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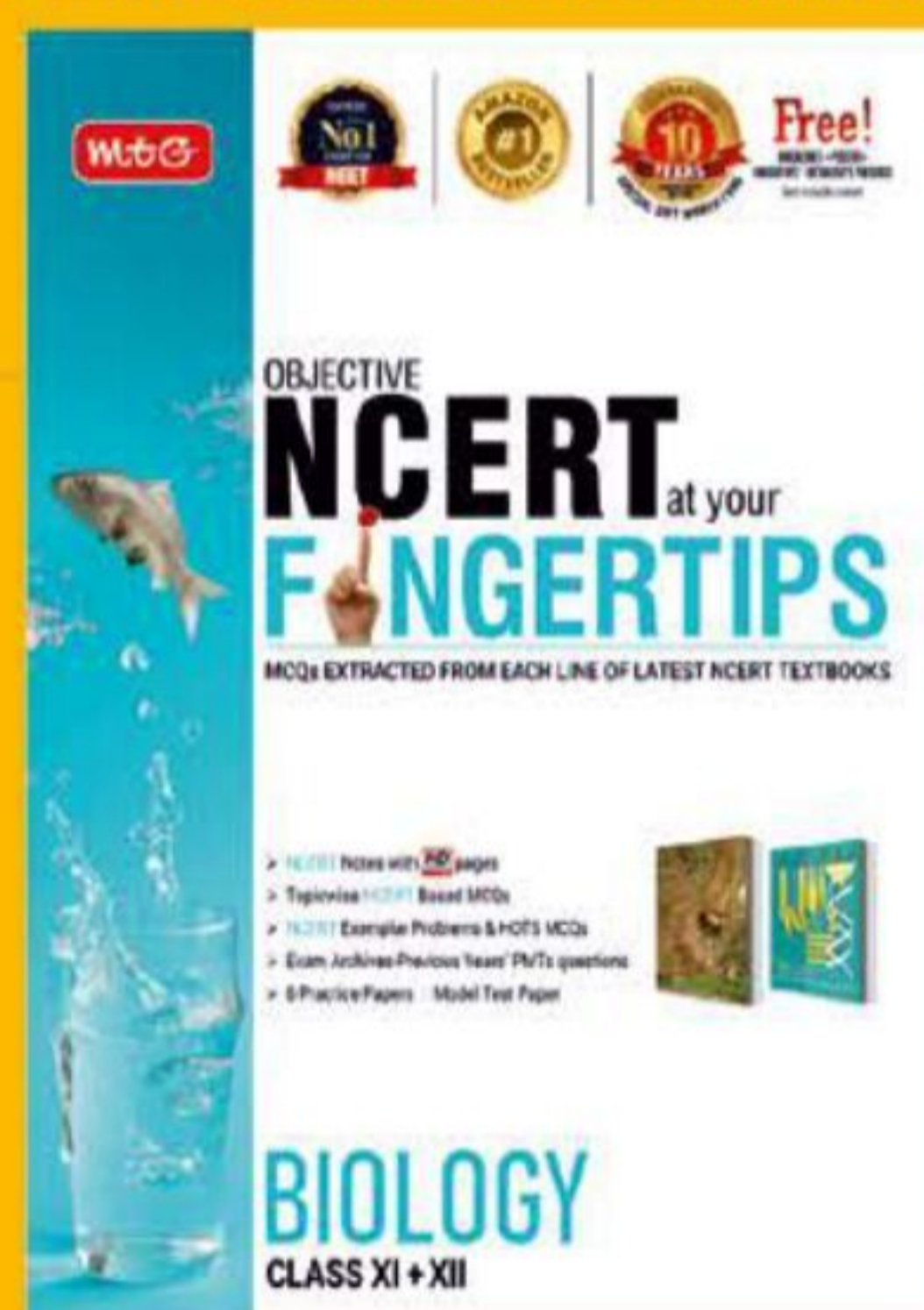
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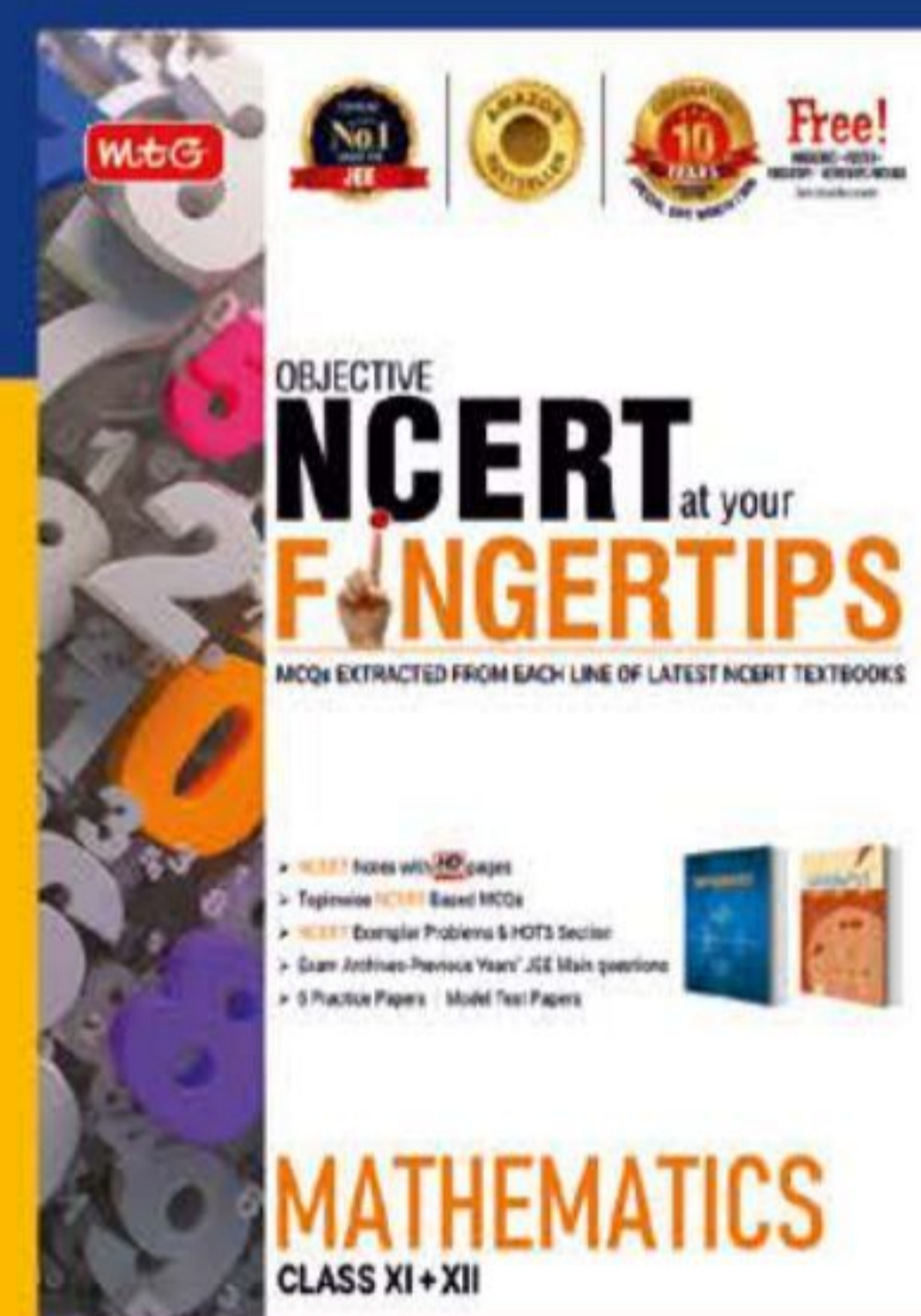
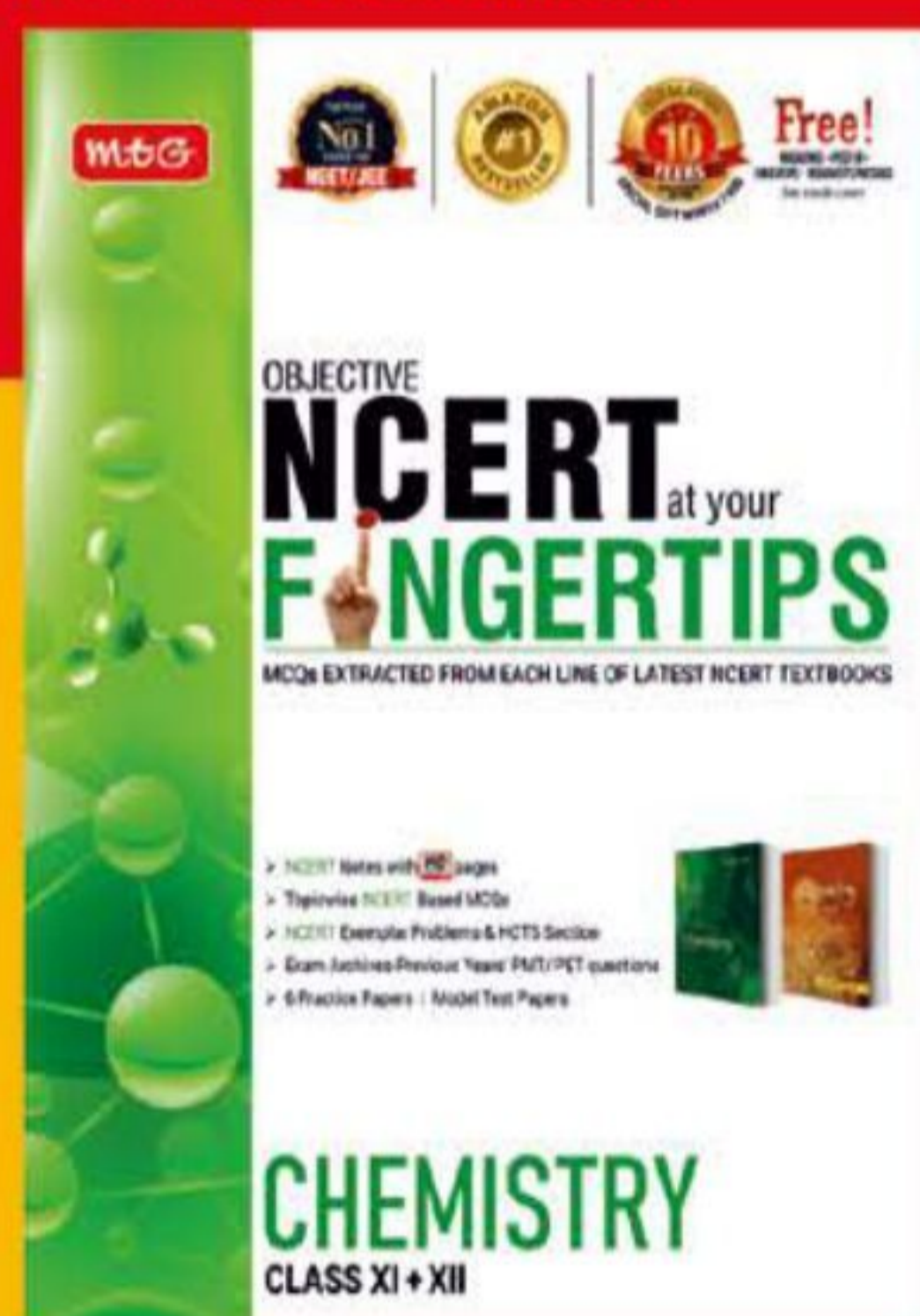
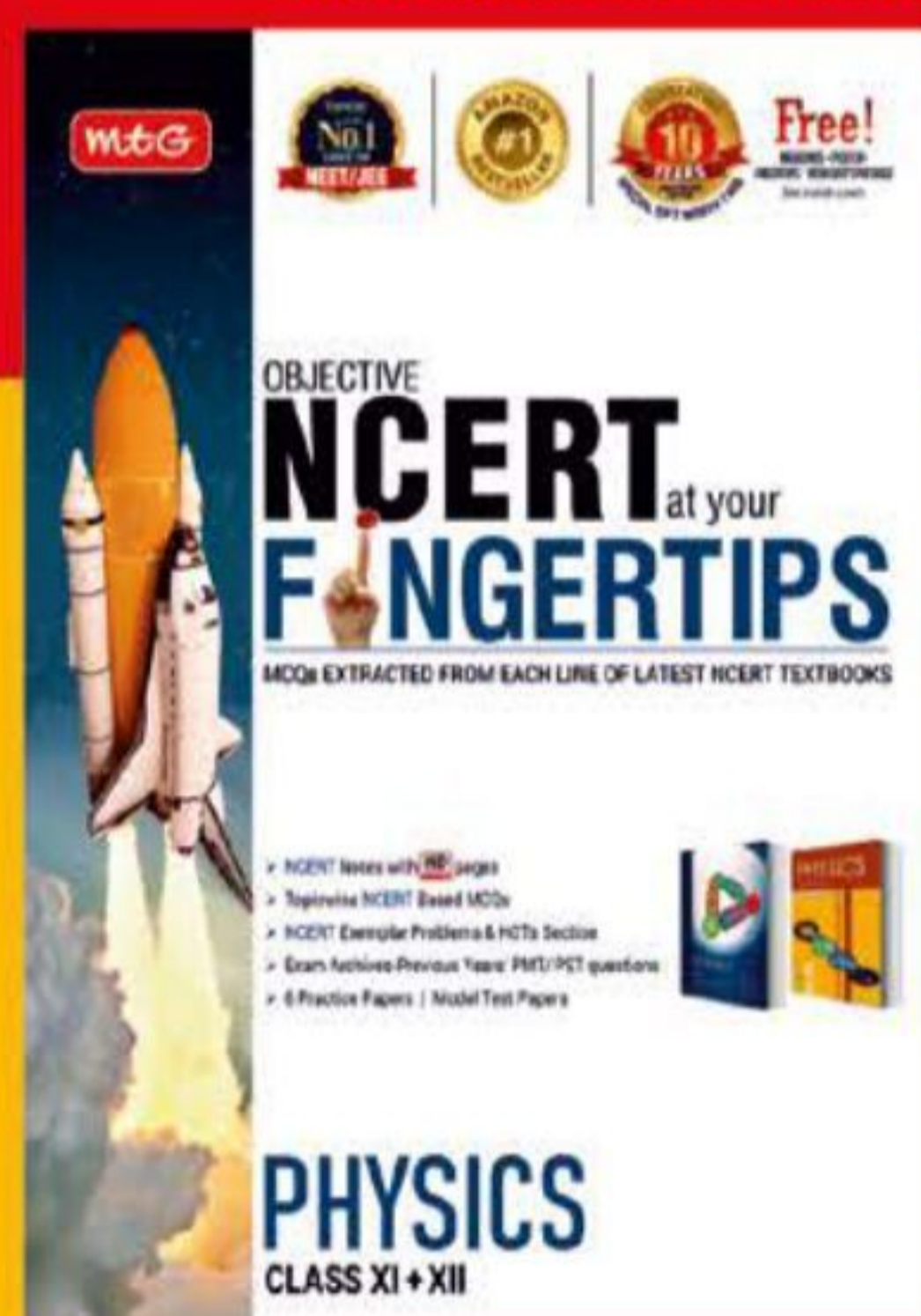
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An organic way to learn Inorganic Chemistry

Keep these tricks up your sleeve to master Inorganic Chemistry, one of the most scoring subjects in JEE and NEET exams.

Believe it

Inorganic Chemistry is the secret weapon to score more in JEE and NEET exams. The general practice among many students is to pay less attention to Inorganic Chemistry as it requires a lot of “mugging up”. Agreed that its preparation does require dedicated time and efforts, but the result will be well worth the efforts.

Also know this

The knowledge from this subject often overlaps or is used in other chapters including several reactions in Mole Concept, Chemical and Ionic Equilibrium, Electrochemistry, Oxidation and Reduction and complete Organic Chemistry. Hence, Inorganic Chemistry can be an aid that defines your performance in Chemistry as a whole.

While there are several aspects of the subject that you have to memorise, you also need to have some level of understanding. You need to know the trends across the periodic table which encompasses similarities between several properties of elements and various reactions. In fact, some topics like Electrochemistry, Chemical Bonding, Solutions and Colligative properties are based entirely on the trends and properties originating in Inorganic Chemistry.

Bond Formation, Bond Order, Overlapping and Hybridisation discussed in Chemical Bonding also play a vital role in almost every organic reaction. The concept of Vacant Orbitals and Lone Pairs is helpful in studying different intermediates of Organic Chemistry. Halogenation is a major reaction of Organic Chemistry which is solely dependent on reactivity of halogens related with p -block.

Let's look at a few tips that might guide you to ace both JEE and NEET exams.

Be well-versed with NCERT

The primary way to prepare for Inorganic Chemistry for JEE and NEET exams is to learn each and everything from NCERT. You might be uninspired to study certain topics, but you mustn't give in. Follow a few simple steps to make future revisions of these topics easier.

- Highlight or underline the important sections, so you don't have to read every line during revision.
- Make your own notes. You can also opt to study from notes created by expert for this subject. This will ensure that you do not miss topics that might be significant from the exam point of view.
- An added benefit of NCERT is that explanation of almost every important topic is followed by examples. If you are

unable to solve these, re-read and understand the concepts of the problem once more. Additionally, NCERT chapter-ends have exercises consisting of easy to advance level questions that are invaluable. Don't miss even a single problem from these exercises.

Use mnemonics or learn by writing

It is not uncommon for students to memorize Inorganic Chemistry through mnemonics — using songs, imagery or abbreviations to remember the subject efficiently. However, if mnemonics is not your cup of tea, you can go the old school way — take notes.

Don't start late

Some students take up Inorganic Chemistry at a much later date. Grasping a vast amount of information in a relatively short span of time is not advisable as the other dependent topics will end up being difficult to comprehend. Hence, make sure to start with this subject early on. Do not spend too much time on it, but just enough to build a strong foundation of all the topics.

Solve lots of questions

Practice, practice and practice those questions again. Our brain processes information better when it goes through the data repeatedly. When you attempt tricky questions, you take different approaches to get to the right answer.

Use notes for revision

One cannot possibly go through the entire NCERT syllabus in the run-up to the exam. This is where notes, especially short notes, come in. You can quickly revise a significant part of the syllabus in a short amount of time without exertion. Hence, maintain a small notebook for Inorganic Chemistry, with your notes being as concise and organised as possible.

Although perceived as one of the difficult subjects, Inorganic Chemistry can in fact prove to be beneficial if studied with sincerity and determination. Put up the periodic table at your study desk. Read and repeat the names, atomic numbers, symbols and atomic weights regularly. In fact, the mere act of 'seeing' the periodic table can help you to retain the information, as repetition of visual or auditory memory is known to translate into long term memory.

Remember, nothing is impossible if you put your mind to it, and in this case memory too.

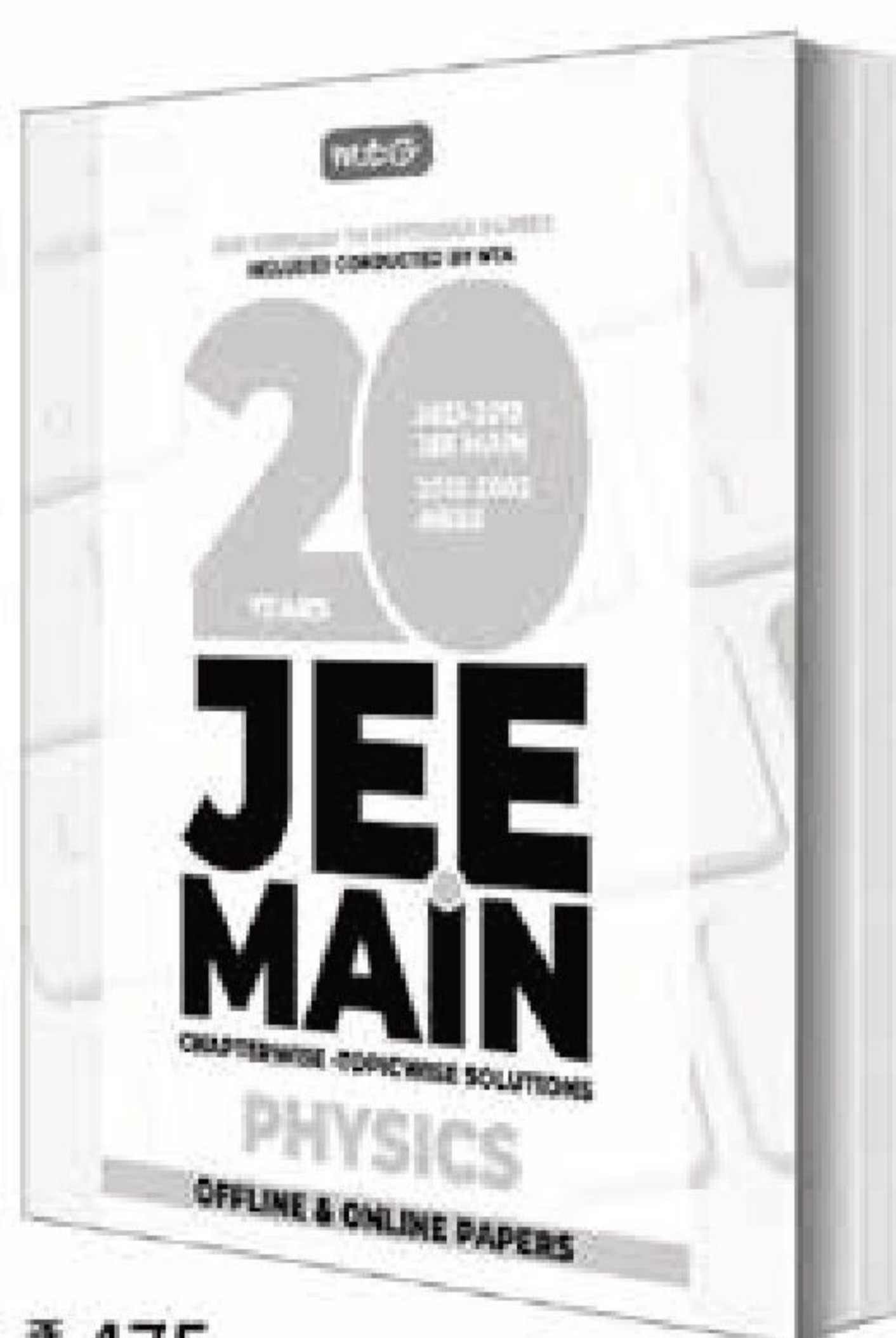
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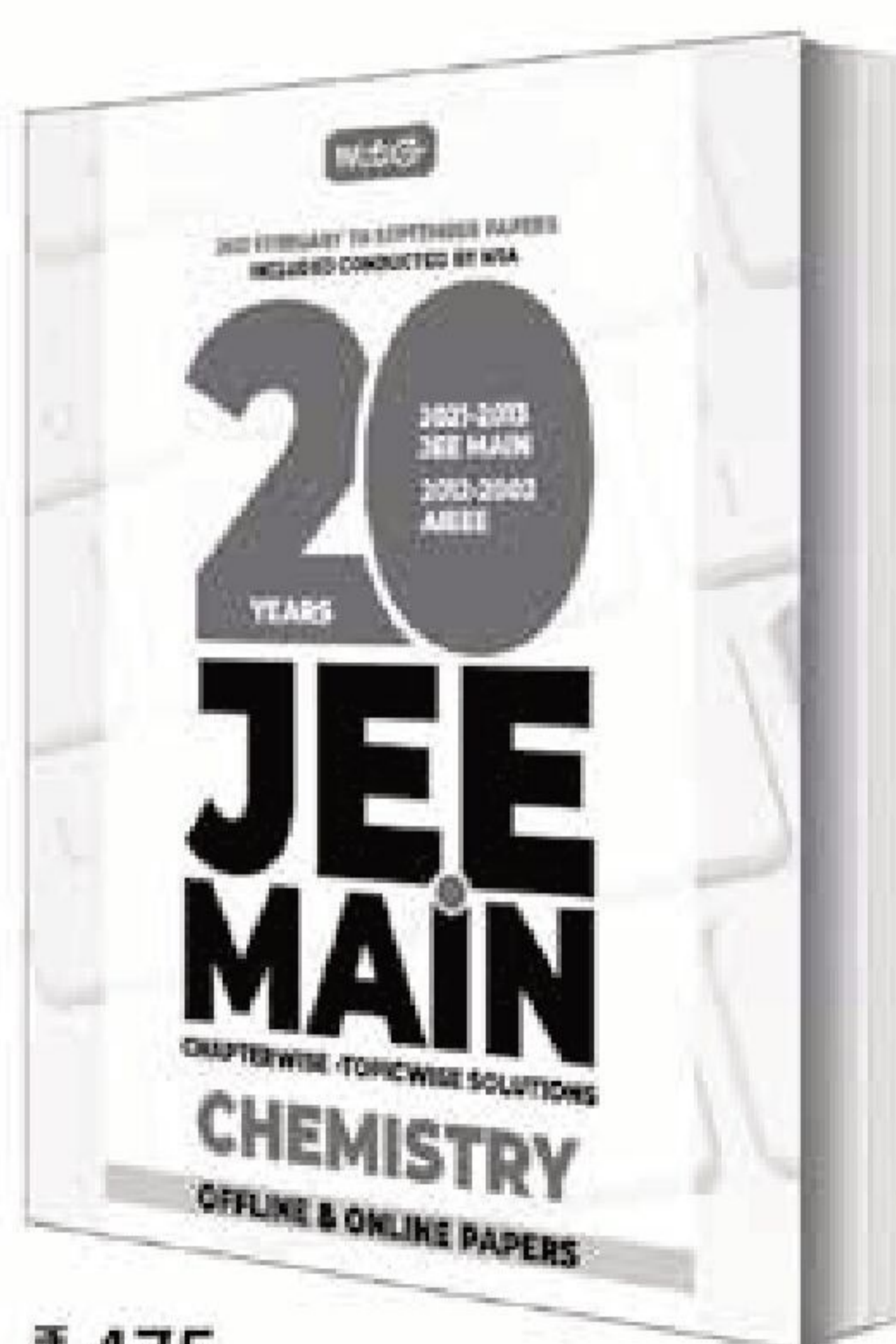
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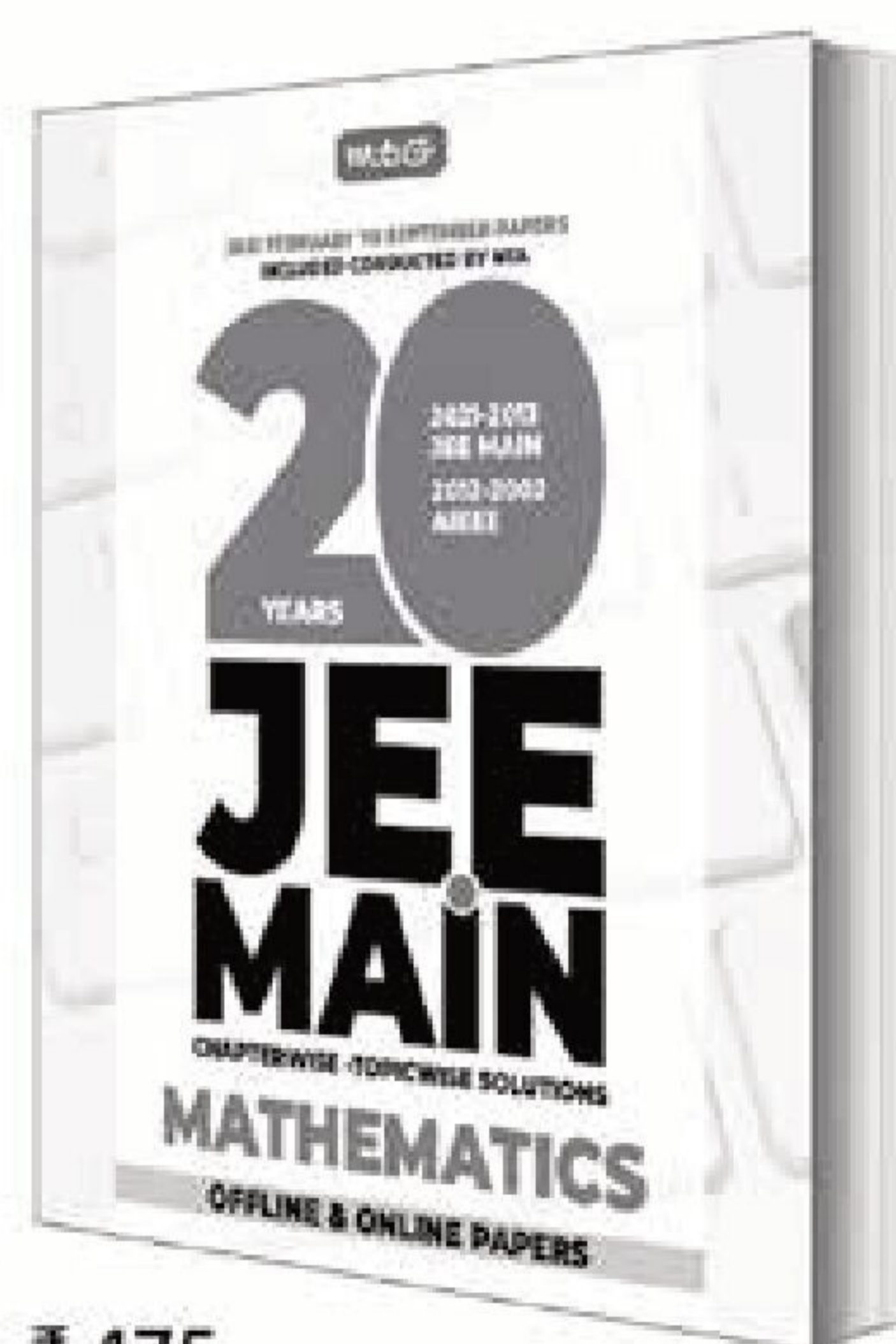
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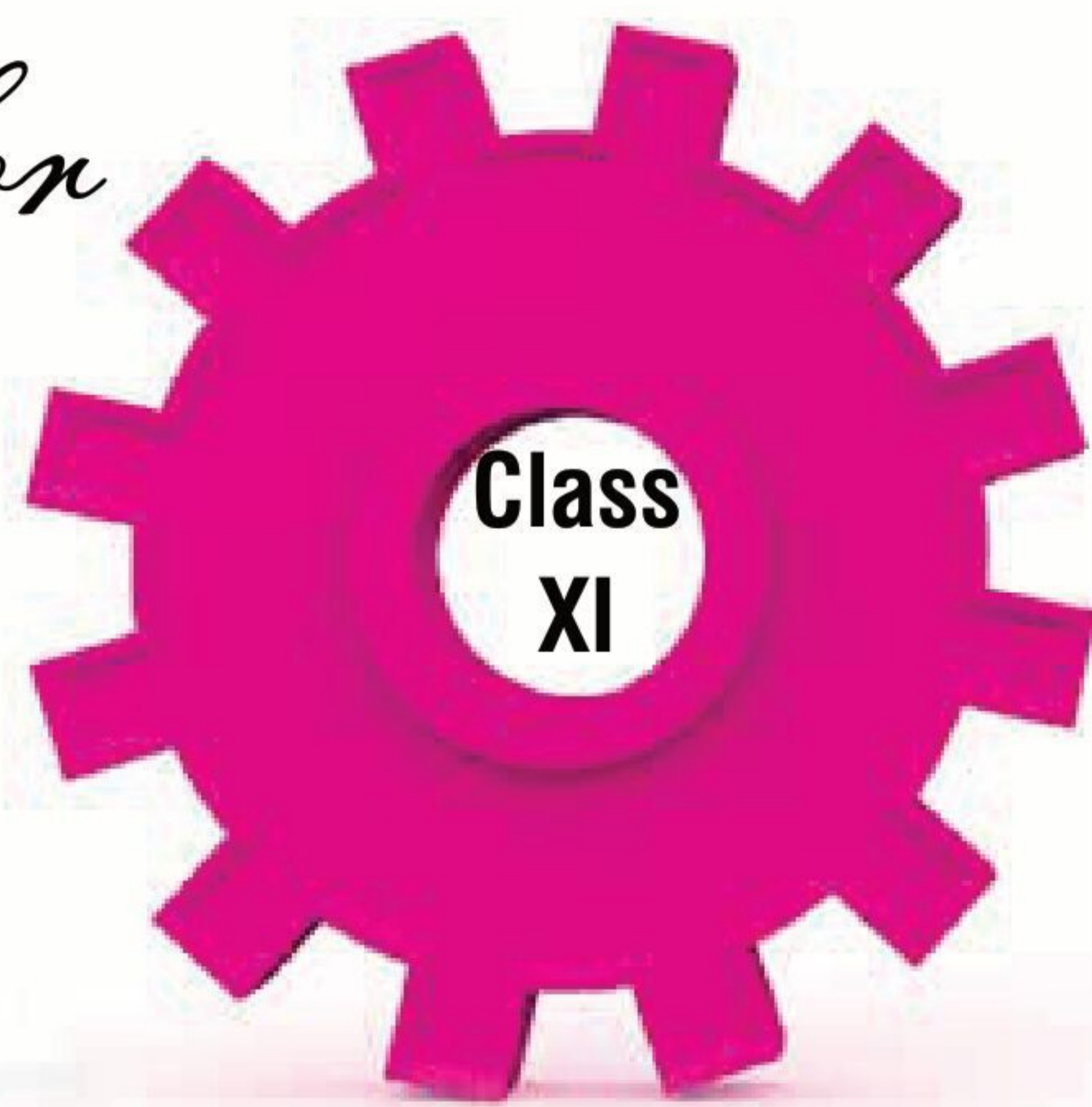
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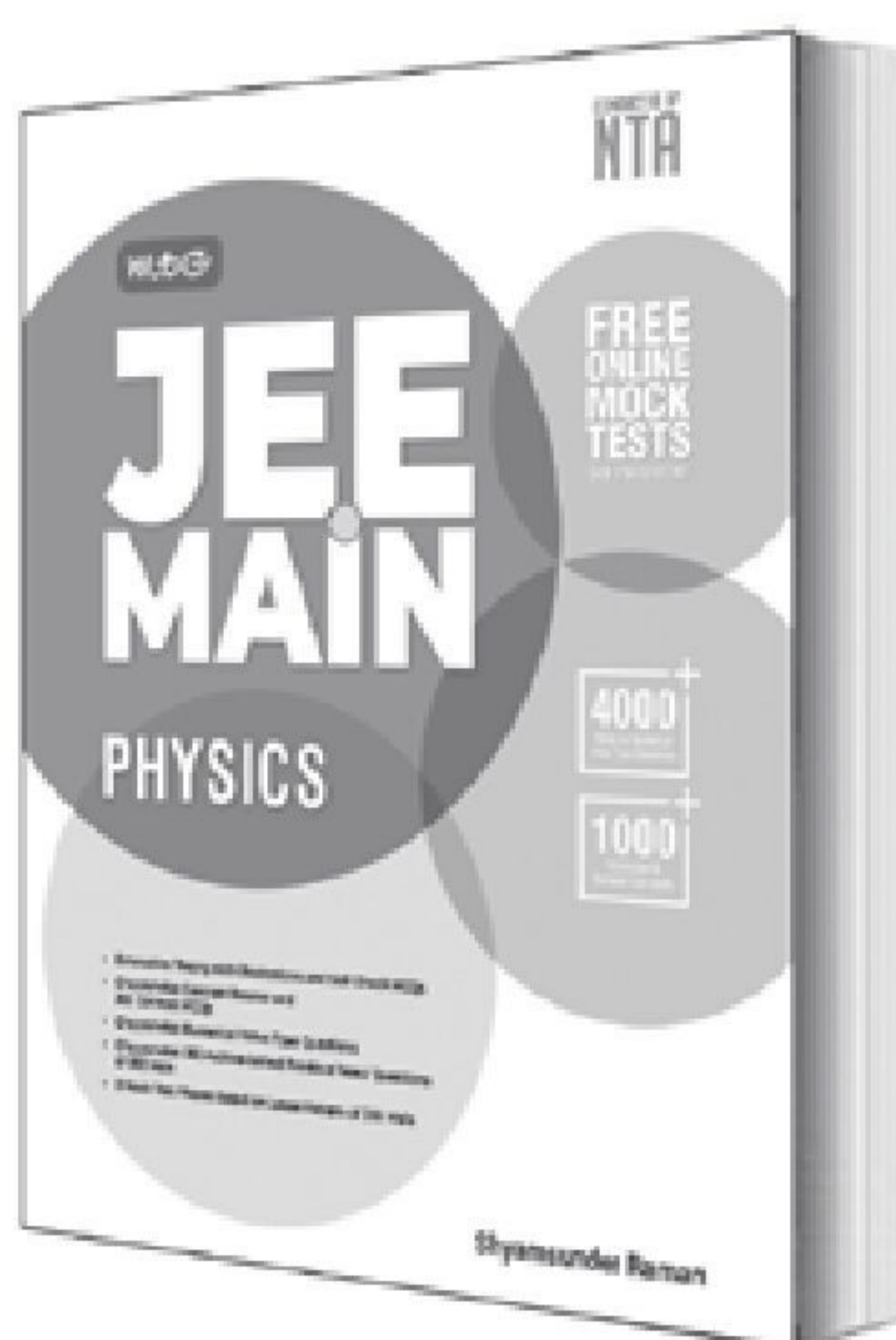
Practicing these MCQs help to strengthen your concepts and give you extra edge in your JEE preparation

- In the reaction,
$$\text{As}_2\text{S}_5 + x\text{HNO}_3 \longrightarrow 5\text{H}_2\text{SO}_4 + y\text{NO}_2 + 2\text{H}_3\text{AsO}_4 + 12\text{H}_2\text{O}$$
the values of x and y respectively are
(a) 40 and 40 (b) 10 and 10
(c) 30 and 30 (d) 20 and 20
- Which of the following statements are true?
I. The highest oxide of a group-15 element (E) is $E_2\text{O}_5$.
II. The elements of period 2 show anomalous behavior.
III. Li/Mg, Be/Al and B/Si are diagonal pairs.
IV. A diagonal relationship exists between two elements because of their similar oxidation states.
(a) I and II only (b) II and IV only
(c) III and IV only (d) I, II and III only
- Heavy water is manufactured
(a) by repeated electrolysis of 3% aqueous NaOH
(b) by electrolysis of water containing heavy hydrogen dissolved in it
(c) by combination of hydrogen and heavier isotope of oxygen
(d) none of the above.
- Consider the following structures :
I. $\text{CH}_2=\overset{+}{\text{CH}}$ II. $\text{CH}_3-\overset{+}{\text{CH}}_2$
III. $\text{CH}_2=\text{CH}-\overset{+}{\text{CH}}_2$ IV. $\text{C}_6\text{H}_5-\overset{+}{\text{CH}}-\text{C}_6\text{H}_5$
The correct sequence of these carbocations in the decreasing order of their stability is
(a) IV, III, II, I (b) I, II, III, IV
(c) IV, II, III, I (d) I, III, II, IV
- The ground state energy of the hydrogen atom is -13.6 eV and the energy of 1^{st} excited state is 10.2 eV higher than the ground state *i.e.*, at -3.4 eV. If a collection of hydrogen atoms in the ground state is irradiated with monochromatic light of energy 11.9 eV, then
(a) light will not be absorbed
(b) the atoms will absorb 10.2 eV to reach the first excited state and the excess energy will be returned as radiation
(c) the atoms will absorb 10.2 eV and the excess energy will be converted into kinetic energy
(d) for every 6 photons absorbed, 7 atoms will be excited.
- Which of the following statements is true about ozone layer?
(a) It is harmful because ozone is dangerous to living organism.

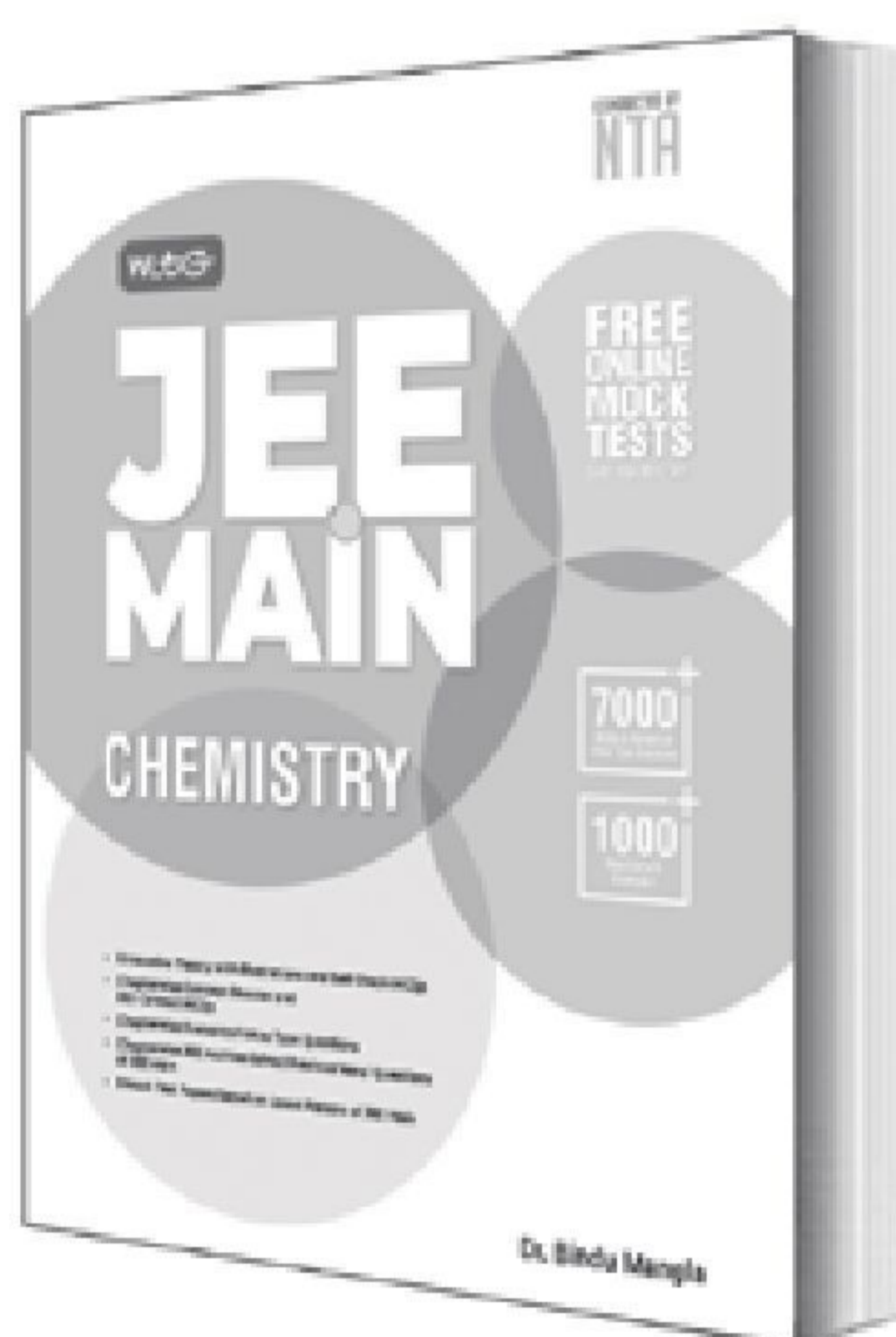
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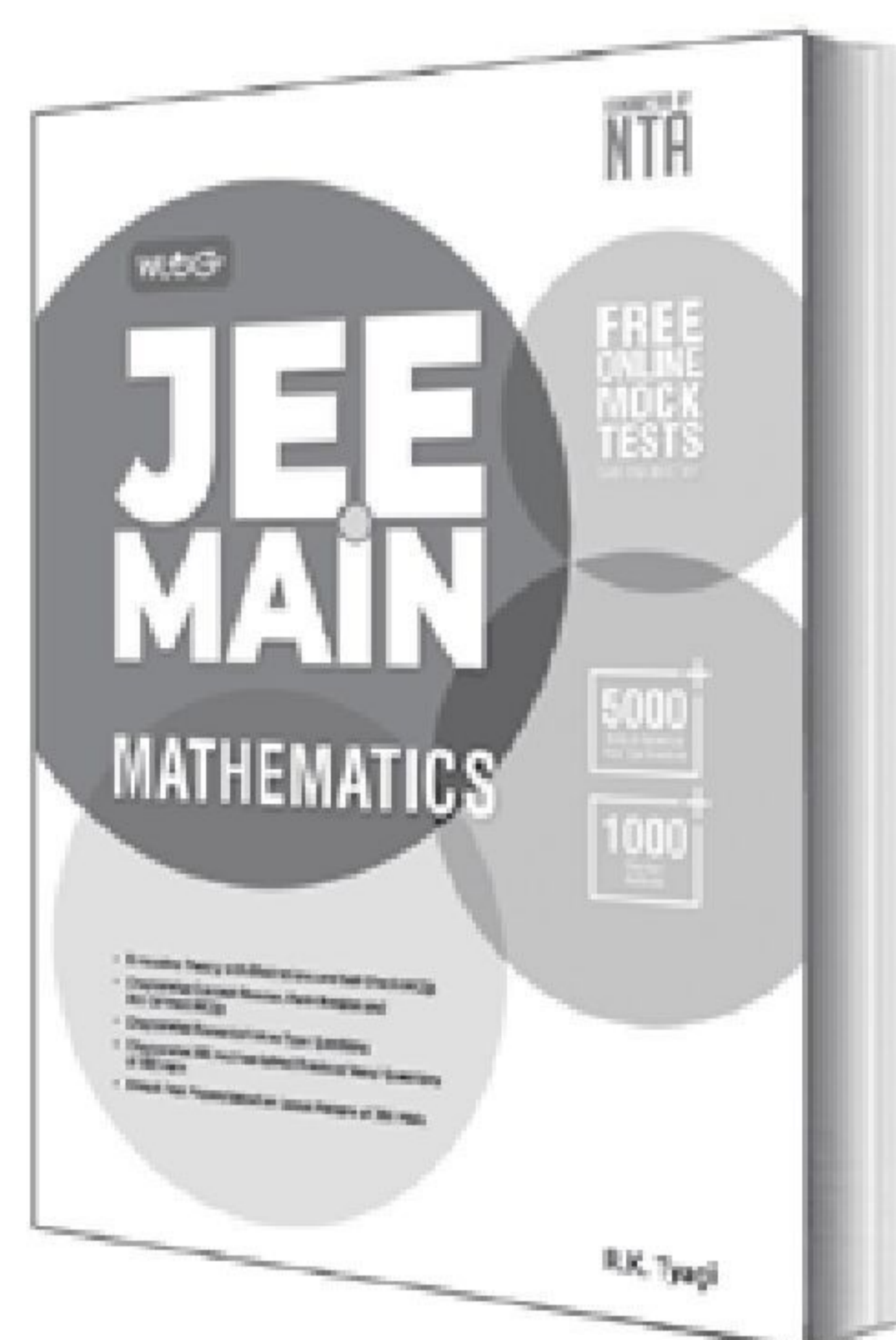
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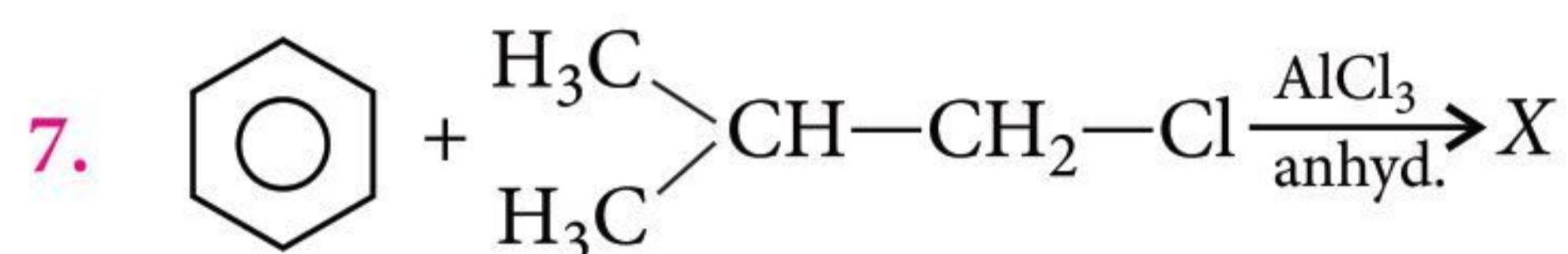
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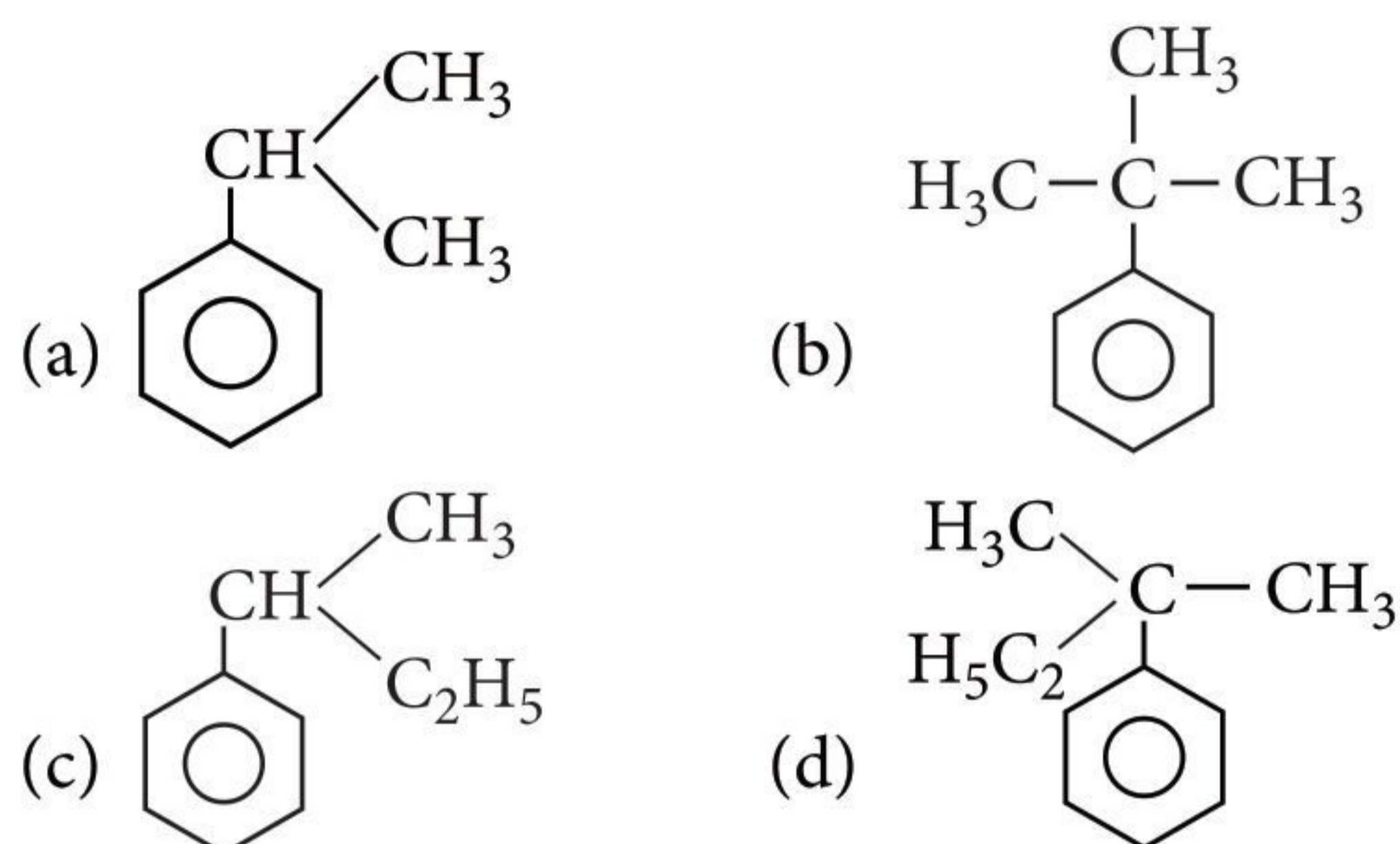
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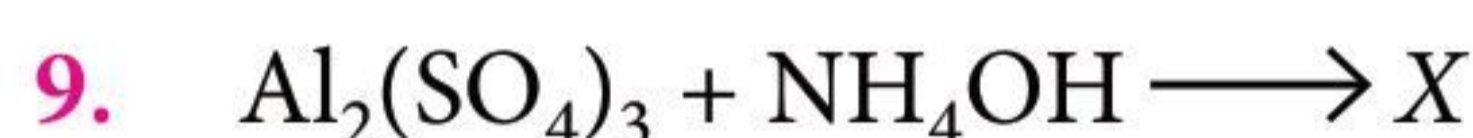
- (b) It is beneficial because oxidation reaction can proceed faster in the presence of ozone.
 (c) It is beneficial because ozone cuts-off the ultraviolet radiation of the sun.
 (d) It is harmful because ozone cuts out the important radiations of the sun which are vital for photosynthesis.



Identify X in the above reaction.



8. Which one of the following pairs is isostructural (*i.e.*, having the same shape and hybridization)?
 (a) BCl_3 and BrCl_3 (b) NH_3 and NO_3^-
 (c) NF_3 and BF_3 (d) BF_4^- and NH_4^+



In the given sequence of reaction, product X is

- (a) a white gelatinous precipitate soluble in excess of NH_4OH
 (b) green precipitate insoluble in excess of NH_4OH
 (c) white precipitate insoluble in excess of NaOH
 (d) no precipitate.
10. During complete combustion of one mole of butane, 2658 kJ of heat is released. The thermochemical reaction for above change is
 (a) $2\text{C}_4\text{H}_{10(g)} + 13\text{O}_{2(g)} \longrightarrow 8\text{CO}_{2(g)} + 10\text{H}_2\text{O}_{(l)}$
 $\Delta_c H = -2658.0 \text{ kJ mol}^{-1}$
 (b) $\text{C}_4\text{H}_{10(g)} + \frac{13}{2}\text{O}_{2(g)} \longrightarrow 4\text{CO}_{2(g)} + 5\text{H}_2\text{O}_{(g)}$
 $\Delta_c H = -1329.0 \text{ kJ mol}^{-1}$
 (c) $\text{C}_4\text{H}_{10(g)} + \frac{13}{2}\text{O}_{2(g)} \longrightarrow 4\text{CO}_{2(g)} + 5\text{H}_2\text{O}_{(l)}$
 $\Delta_c H = -2658.0 \text{ kJ mol}^{-1}$
 (d) $\text{C}_4\text{H}_{10(g)} + \frac{13}{2}\text{O}_{2(g)} \longrightarrow 4\text{CO}_{2(g)} + 5\text{H}_2\text{O}_{(l)}$
 $\Delta_c H = +2658.0 \text{ kJ mol}^{-1}$
11. In which of the following reactions, increase in temperature as well as decrease in pressure shift the equilibrium towards the forward direction :

- (i) $\text{PCl}_{5(g)} \rightleftharpoons \text{PCl}_{3(g)} + \text{Cl}_{2(g)}$; $\Delta H = + \text{ve}$
 (ii) $\text{N}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{NO}_{(g)}$; $\Delta H = + \text{ve}$
 (iii) $2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$; $\Delta H = - \text{ve}$
 (iv) $\text{N}_2\text{O}_{4(g)} \rightleftharpoons 2\text{NO}_{2(g)}$; $\Delta H = + \text{ve}$
 (a) (ii) and (iii) only (b) (i) and (iv) only
 (c) (i) and (ii) only (d) (iii) and (iv) only

12. Which of the following is the correct observation regarding polarisation power?

- (a) Na^+ has inert gas configuration which has greater polarisation power.
 (b) Ag^+ has inert gas configuration which has greater polarisation power.
 (c) Ag^+ has pseudo inert gas configuration which has lesser polarisation power.
 (d) Ag^+ has pseudo inert gas configuration which has greater polarisation power.

NUMERICAL PROBLEMS

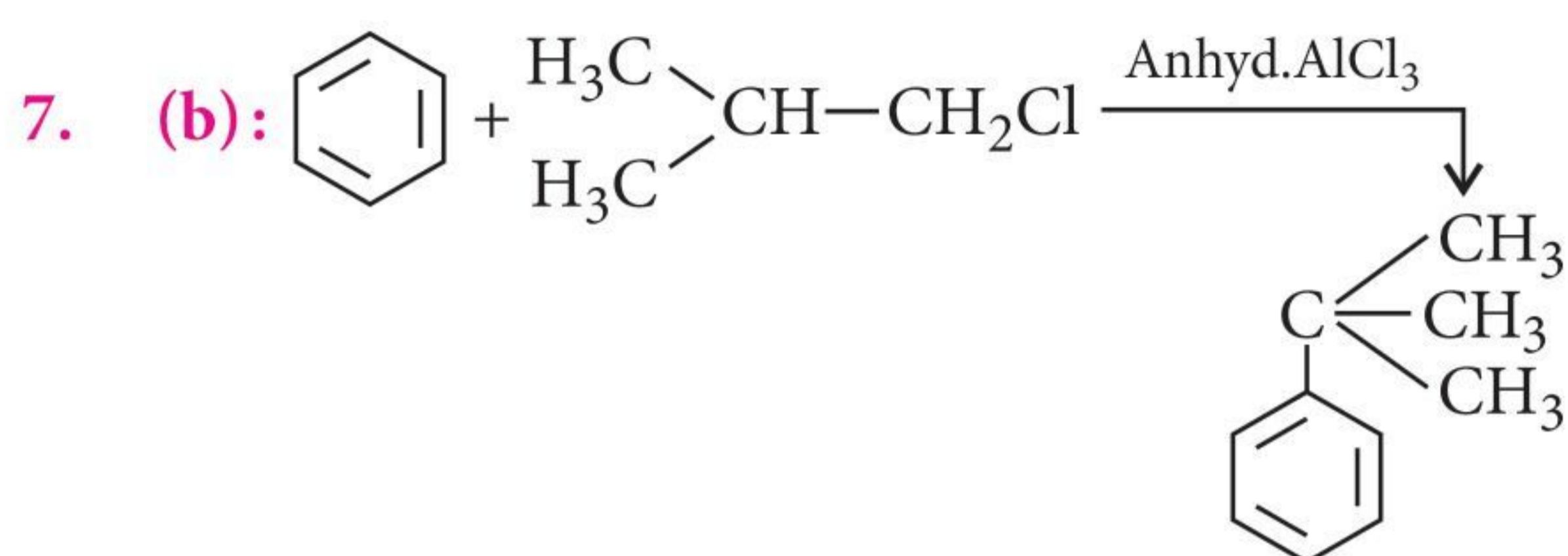
13. Calculate the molarity of one litre of a 93% (weight/volume) H_2SO_4 solution. The density of the solution is 1.84 g/mL.
 14. An LPG (Liquefied Petroleum Gas) cylinder weighs 14.8 kg when empty. When full, it weighs 29.0 kg and shows a pressure of 2.5 atm. In the course of use at 27°C , the mass of the full cylinder is reduced to 23.2 kg. Find out the final pressure (in atm) inside the cylinder. Assume LPG to be *n*-butane with normal boiling point of 0°C .
 15. If 0.24 g of a volatile liquid upon vaporisation gives 48 mL of vapours at NTP. What will be the vapour density of the substance? (Density of $\text{H}_2 = 0.089 \text{ g L}^{-1}$)

SOLUTIONS

1. (a) : The balanced equation is,
 $\text{As}_2\text{S}_5 + 40\text{HNO}_3 \longrightarrow 5\text{H}_2\text{SO}_4 + 40\text{NO}_2 + 2\text{H}_3\text{AsO}_4 + 12\text{H}_2\text{O}$
 2. (d) : Diagonal relationship exists between two element due to the similarity in ionic sizes and charge/radius ration of the elements.
 3. (a) : Heavy water is manufactured by repeated electrolysis of water (containing a little NaOH).
 4. (a) : Presence of two phenyl groups in (IV) causes increased stability through resonance effect,

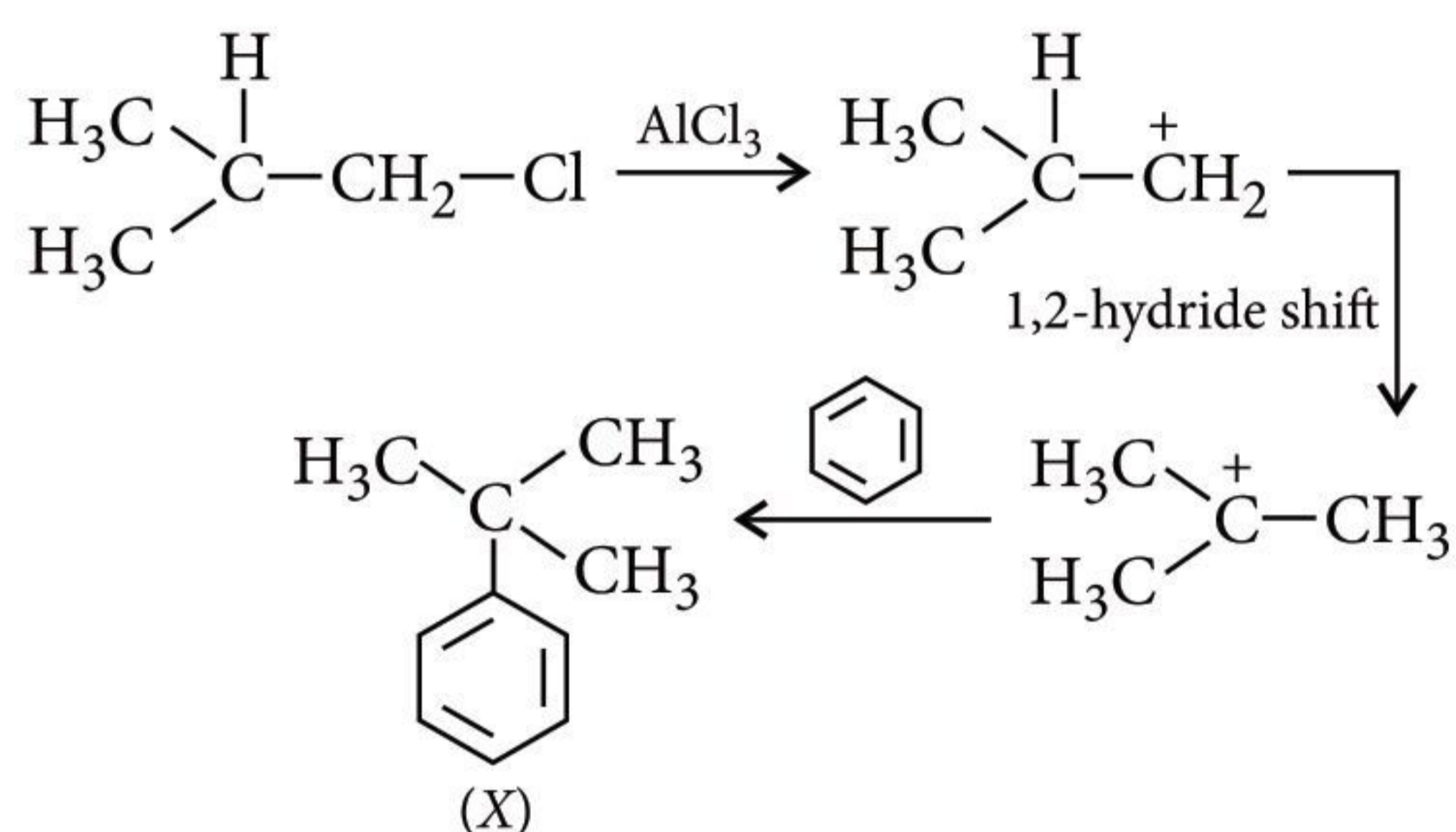
resonance also stabilizes allyl cation (III) but it is less stable than (IV). Out of $\text{CH}_2=\text{CH}^+$ and $\text{CH}_3-\text{CH}_2^+$, the latter is more stable due to +I effect of $-\text{CH}_3$ group. Thus, $\text{IV} > \text{III} > \text{II} > \text{I}$.

5. (a) : When an electron absorbed energy of 11.9 eV, it was 10.2 eV energy for excitation and remaining energy changes into kinetic energy.
6. (c) : Ozone layer in the stratospheres cuts off 99.5% of sun's harmful ultraviolet (UV) radiations from reaching the earth's surface.



This reaction is an example of Friedel—Crafts reaction.

Mechanism :



8. (d)
9. (a) : $\text{Al}_2(\text{SO}_4)_3$ reacts with NH_4OH to form a white gelatinous precipitate of $\text{Al}(\text{OH})_3$ which is soluble in excess of NH_4OH .
- $$\text{Al}_2(\text{SO}_4)_3 + 3\text{NH}_4\text{OH} \longrightarrow 2\text{Al}(\text{OH})_3 + 3(\text{NH}_4)_2\text{SO}_4$$
10. (c) 11. (b)
12. (d) : Due to pseudo inert gas configuration, Ag^+ has greater polarising power.
13. (10.4) : 93%(weight/volume) means 93 g of H_2SO_4 present in 100 mL of solution.
- Mass of 100 mL solution
- $$= 100 \text{ mL} \times 1.84 \text{ g/mL} = 184 \text{ g}$$
- A 100 mL of 93% (weight/volume) of H_2SO_4 solution weight = 184 g
- Hence, the mass of water in 100 mL of the solution
- $$= 184 \text{ g} - 93 \text{ g} = 91 \text{ g}$$

Now, 91 g of water dissolves 93 g of H_2SO_4 .

$$\therefore 1000 \text{ g of water dissolves} = \frac{93}{91} \times 1000 \text{ g of } \text{H}_2\text{SO}_4$$

$$= 1021.98 \text{ g of } \text{H}_2\text{SO}_4$$

$$\text{The number of moles of } \text{H}_2\text{SO}_4 = \frac{1021.98 \text{ g}}{98 \text{ g/mol}}$$

$$= 10.4 \text{ mol}$$

\therefore Molarity of the solution is 10.4 M

14. (1.48) : Weight of LPG originally present
- $$= 29.0 - 14.8 = 14.2 \text{ kg}$$

Pressure = 2.5 atm

$$\text{Weight of L.P.G. present after use} = 23.2 - 14.8$$

$$= 8.4 \text{ kg}$$

Since volume of the cylinder is constant, applying

$$pV = nRT$$


$$\frac{p_1}{p_2} = \frac{n_1}{n_2} = \frac{W_1/M}{W_2/M} = \frac{W_1}{W_2}; \frac{2.5}{p_2} = \frac{14.2}{8.4}$$

$$p_2 = \frac{2.5 \times 8.4}{14.2} = 1.48 \text{ atm}$$

15. (56) : Molecular mass = $\frac{22.4 \times W}{V_g}$
- (By Victor Meyer method)

$$\text{Molecular mass} = \frac{0.24 \times 22400}{48} = 112$$


$$\text{Vapour density} = \frac{\text{Molecular mass}}{2} = \frac{112}{2} = 56$$



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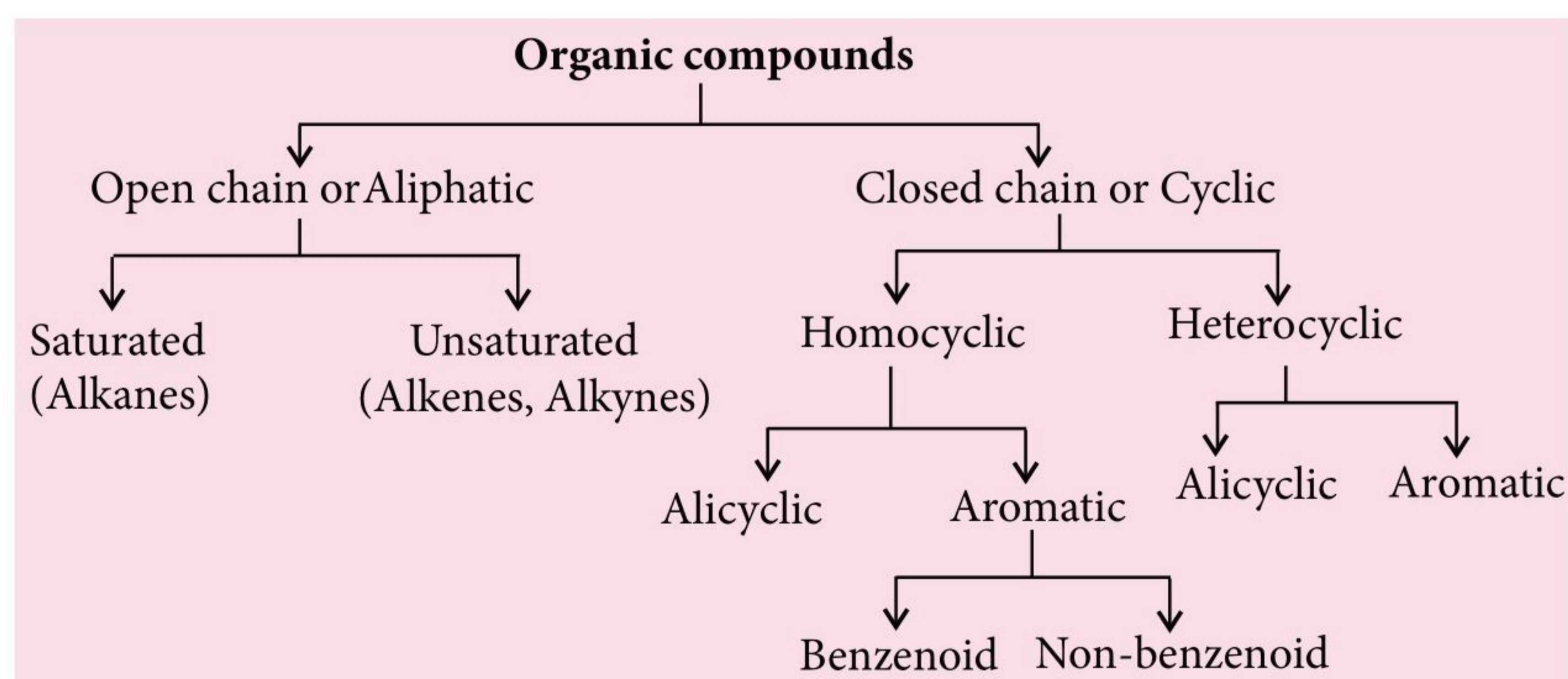
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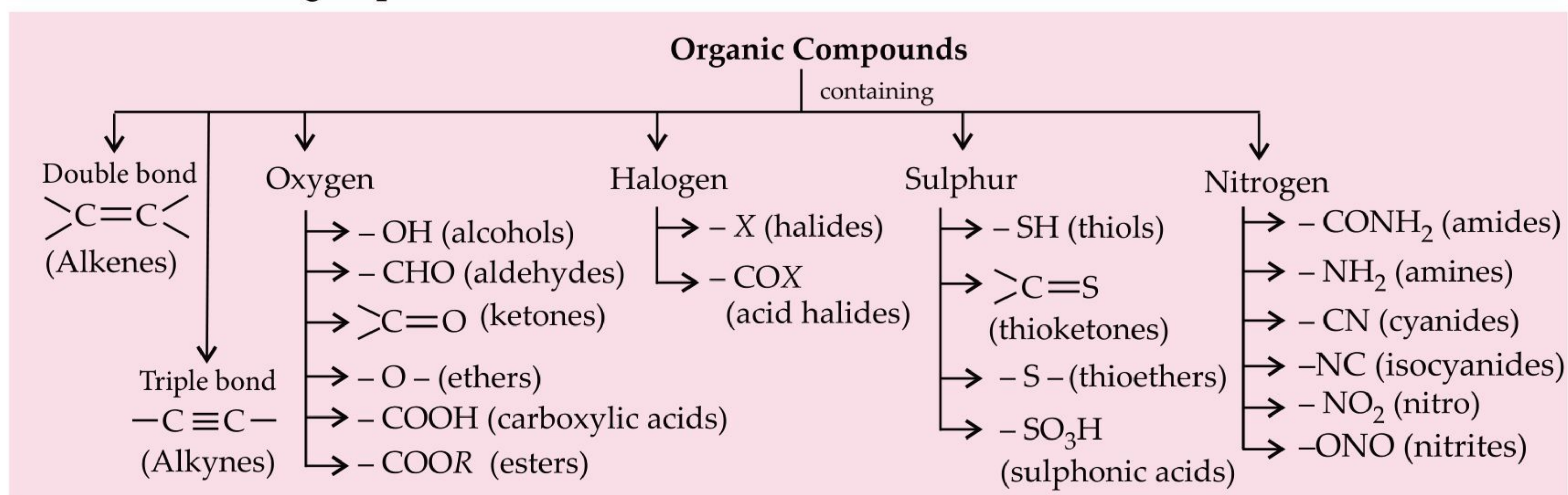
Organic Chemistry - Some Basic Principles and Techniques

CLASSIFICATION OF ORGANIC COMPOUNDS

Based on structure :



Based on functional groups :



HOMOLOGOUS SERIES

- A series of organic compounds each containing a characteristic functional group forms a homologous series in which each successive member differs by a $-\text{CH}_2$ group or by $12 + 2 \times 1 = 14$ mass units.

The members of the series are called *homologues* and the phenomenon is called *homology*.

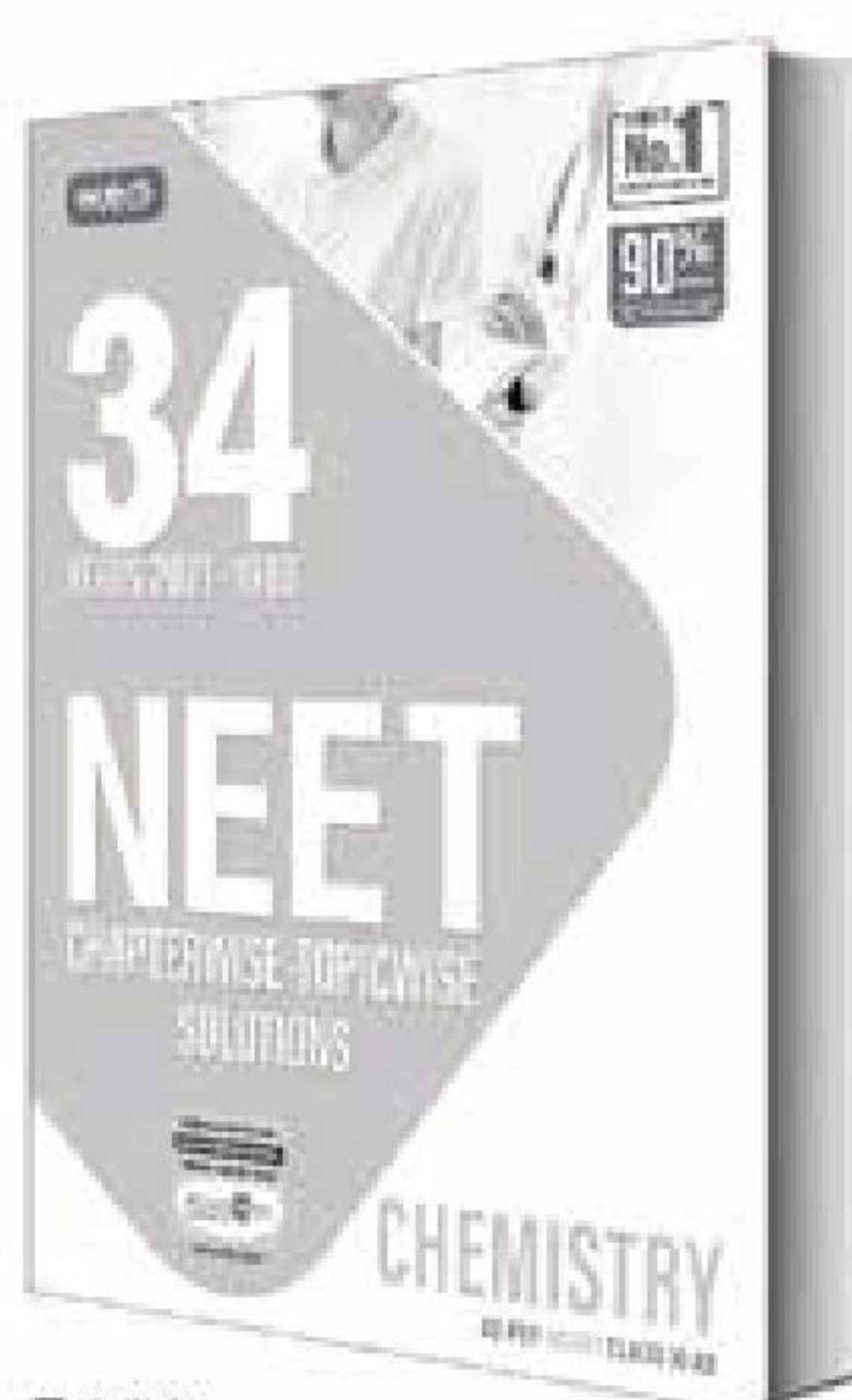
- There are a number of homologous series of organic compounds. Some of these are alkanes, alkenes, alkynes, haloalkanes, alkanols, alkanals, alkanones, alkanolic acids, amines etc.

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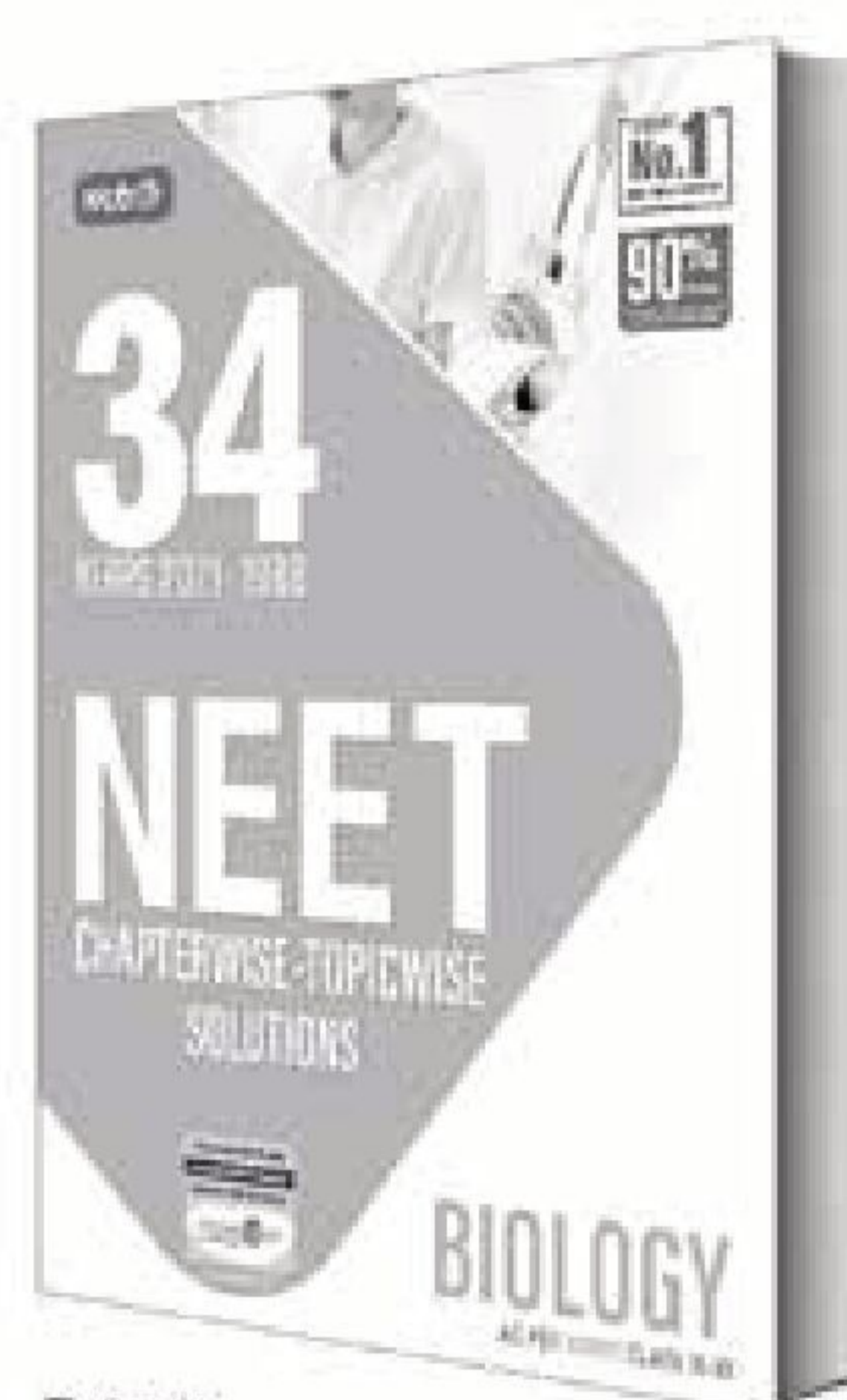
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HIGHLIGHTS:

- Chapterwise -Topicwise questions of last 34 years' (2021-1988) of NEET/AIPMT
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IUPAC NOMENCLATURE

IUPAC Name : 2° prefix + 1° prefix + root word + 1° suffix + 2° suffix

Root word

The root word indicates the number of carbon atoms in the parent chain.

For C_1 -meth, C_2 -eth, C_3 -prop(a), C_4 -but(a), C_5 -pent(a), C_6 -hex(a), C_7 -hept(a), C_8 -oct(a), C_9 -non(a), C_{10} -dec(a), C_{11} -undec(a), C_{12} -dodec(a).

Extra 'a' is added to root word if 1° suffix begins with a consonant. In general, the root word for any carbon chain is alk.

Suffix

A suffix designates the functional groups present in the compound. The suffix is again divided into primary and secondary.

Prefix

The parts of the name that precede the root word are called prefixes. The prefix is again divided into primary and secondary.

Primary suffix

- Primary suffix indicates the degree of saturation or unsaturation in the parent chain and is added immediately after the root word.
- Root word + Primary suffix → saturated or unsaturated carbon chain.
 - Single bonds only –ane, e.g., $CH_3CH_2CH_3$, root word – prop primary suffix – ane
- 1(=) bond, –ene e.g., $CH_3-CH=CH-CH_3$, root word: but primary suffix: -ene
- 2(=) bonds, –diene
- 3(=) bonds, –triene
- 1(≡) bond, –yne e.g., $CH\equiv C-CH_2-CH_3$, root word: but primary suffix: -yne
- 2(≡) bonds, –diyne

Secondary suffix

- A secondary suffix indicates the functional group present in the carbon compound.
- Functional group, $-OH$ (-ol), $-CHO$ (-al), $>CO$ (-one), $-COOH$ (-oic acid), $-CONH_2$ (-amide), $-COCl$ (-oyl chloride), $-COOR$ (oate), $-CN$ (nitrile), $-SH$ (thiol), $-NH_2$ (amine), $-SO_3H$ (sulphonic acid).
- If 2° suffix begins with a vowel, the terminal 'e' is dropped otherwise it is retained.

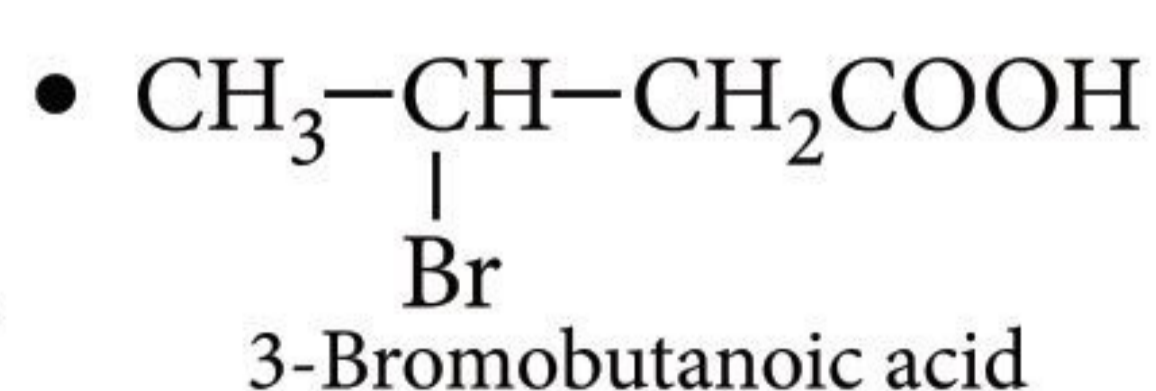
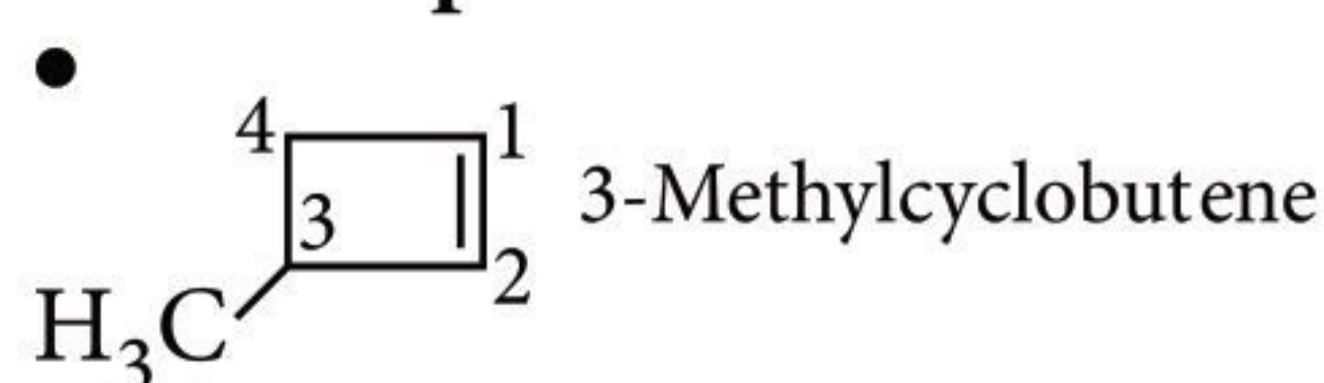
Primary prefix

A primary prefix is used to differentiate acyclic and cyclic compounds. But the rules for using these are slightly different. e.g., in cyclic compounds, the prefix cyclo is added before the root word.

Secondary prefix

- Some functional groups are always treated as substituents whether organic compound is mono or polyfunctional e.g., fluoro ($-F$), chloro ($-Cl$), bromo ($-Br$), iodo ($-I$), nitro ($-NO_2$), nitroso ($-NO$), diazo ($-N\equiv N$), alkoxy ($-OR$), alkyl ($-R$), phenyl ($-C_6H_5$), etc.
- When functional groups act as substituents in the presence of other principal functional group e.g., hydroxyl ($-OH$), formyl ($-CHO$), oxo or keto ($>CO$), cyano ($-CN$), carboxy ($-COOH$), alkoxycarbonyl ($-COOR$), halocarbonyl ($-COX$), amino ($-NH_2$), carbamoyl ($-CONH_2$), sulpho ($-SO_3H$)

For example :



For Aromatic Compounds

- The aromatic compound has two main parts :

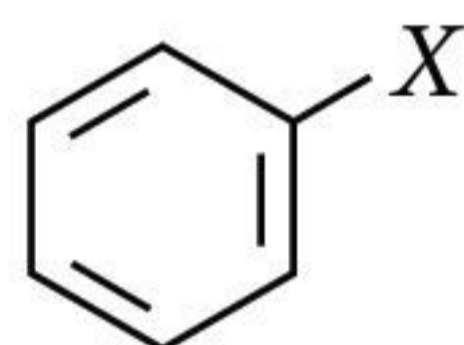
(a) Nucleus

It is benzene ring where all the six carbon atoms are in sp^2 -hybridised state as there is alternate double and single bond. It is represented as—

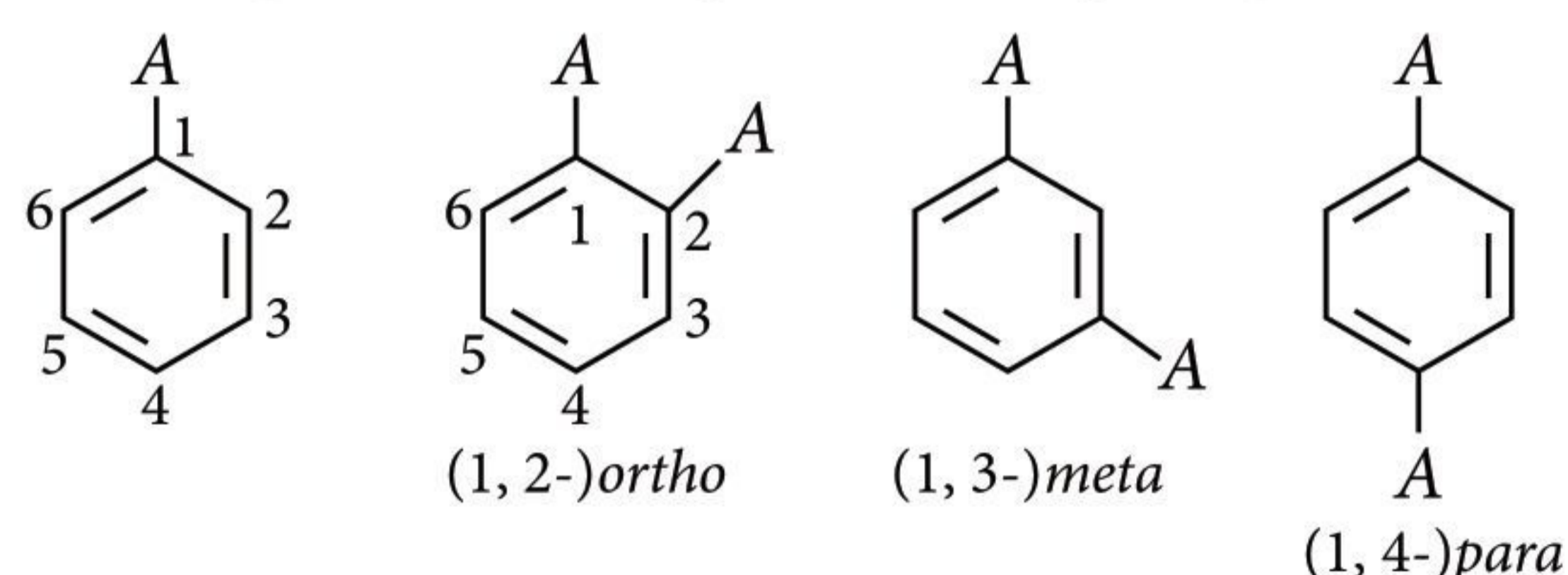


(b) Side chain

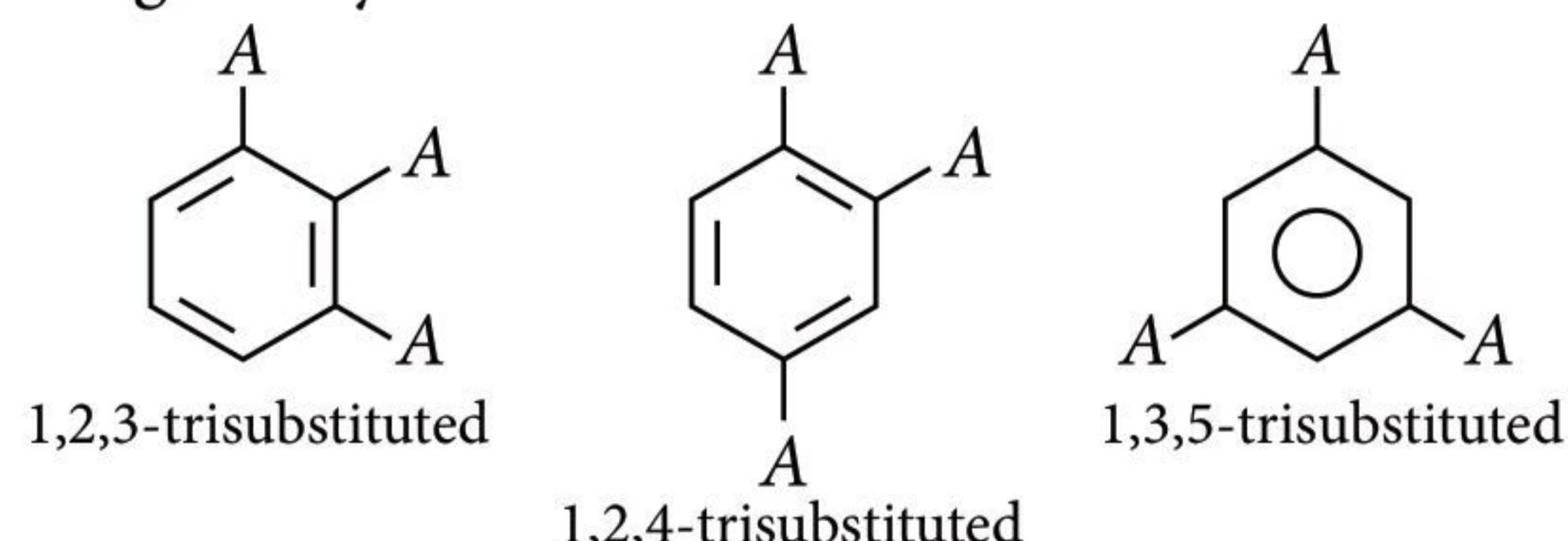
- Alkyl or any other aliphatic group attached to benzene nucleus is called side chain. This is obtained by replacing one or more hydrogen atoms in the ring by alkyl radicals.
- If one of the hydrogen atom of ring is substituted by an alkyl radical or a group then it is called as monosubstituted derivative. This substituent may be present at the either carbon atom of the six carbon atoms as all are of the same type because they are in sp^2 -hybridised state.



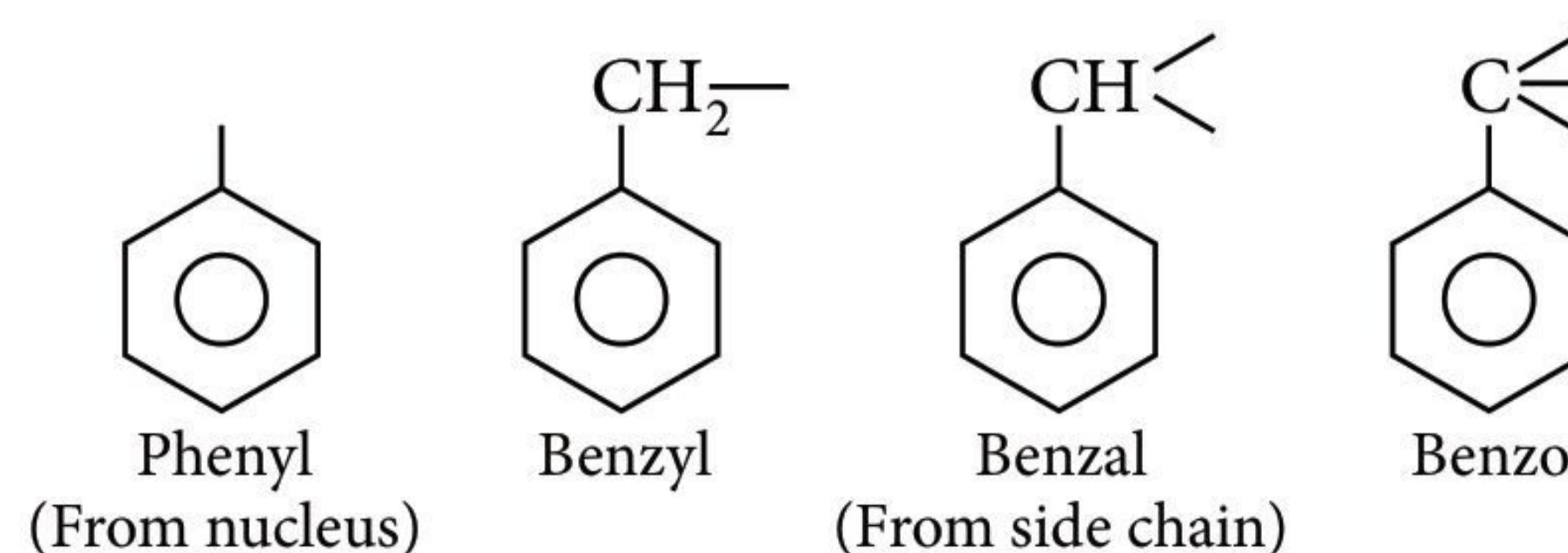
On the other hand when two hydrogen atoms of benzene ring are substituted by the substituents, then position of second substituent with respect to first one will form different forms. For example 2nd and 6th positions of a ring with respect to first are called *ortho*-positions. 3rd and 5th positions of a ring with respect to first one are called *meta*-positions and 4th position of ring is called as *para*-position.



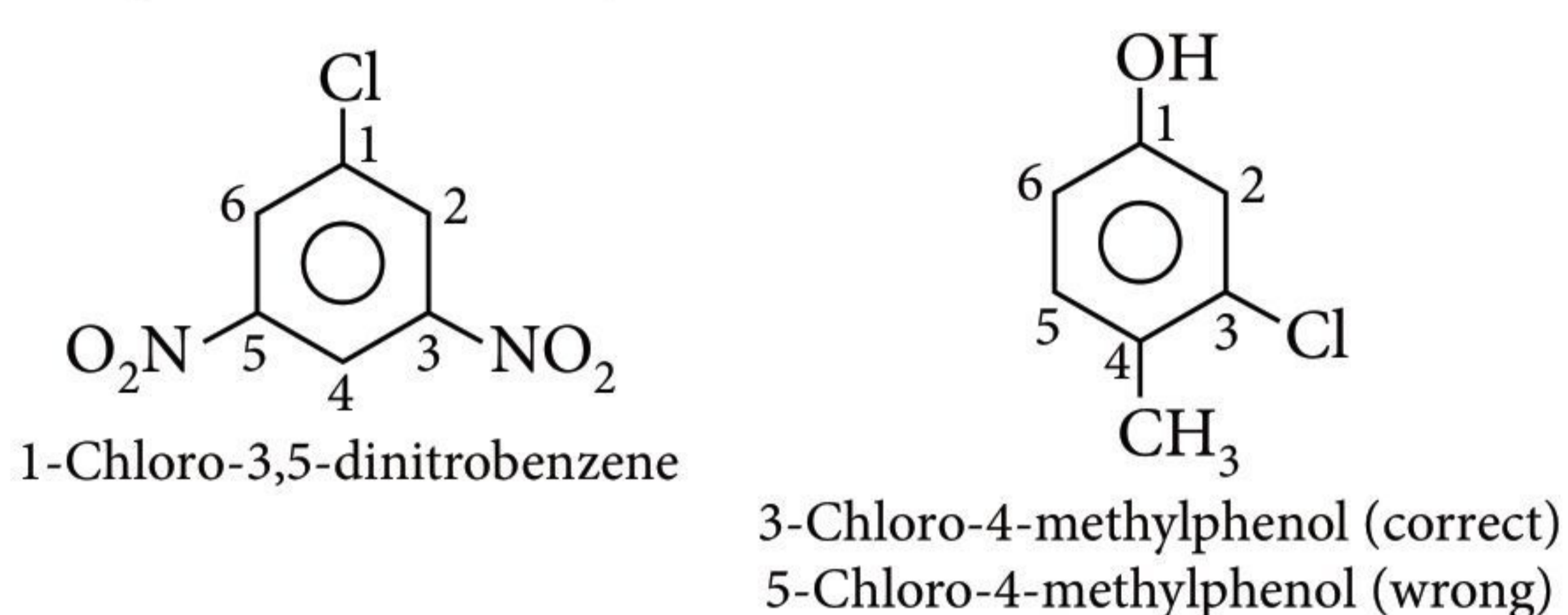
In the case of trisubstituted compounds, the names are given by numbers :



- Aryl group is a radical obtained by removal of one or more hydrogen atoms of the aromatic hydrocarbons either from side chain or from nucleus.



- For polyfunctional benzene derivative we position the substituents by indicating arabic numerals. The principal functional group is given the lowest number (1) and then the direction of numbering is chosen in such a way that the next substituents get the least locant. The name of substituents are written alphabetically along with their positions as prefix. For example :



- Bicyclic compounds are named by adding prefix bicyclo to the name of hydrocarbon corresponding to total number of carbon atoms in two rings. In Bicyclo [3.2.1] octane between the words bicyclo and alkane an expression in the square brackets is placed that represents the number of carbon atoms in each bridge connecting two bridge heads, in descending order separated from one another by full stop.
- If substituent is present, we number the bridged ring system beginning at one bridge head, proceeding first along the longest bridge to the other bridge head, then along the next longest bridge back to the first bridge head. The shortest bridge is numbered last.

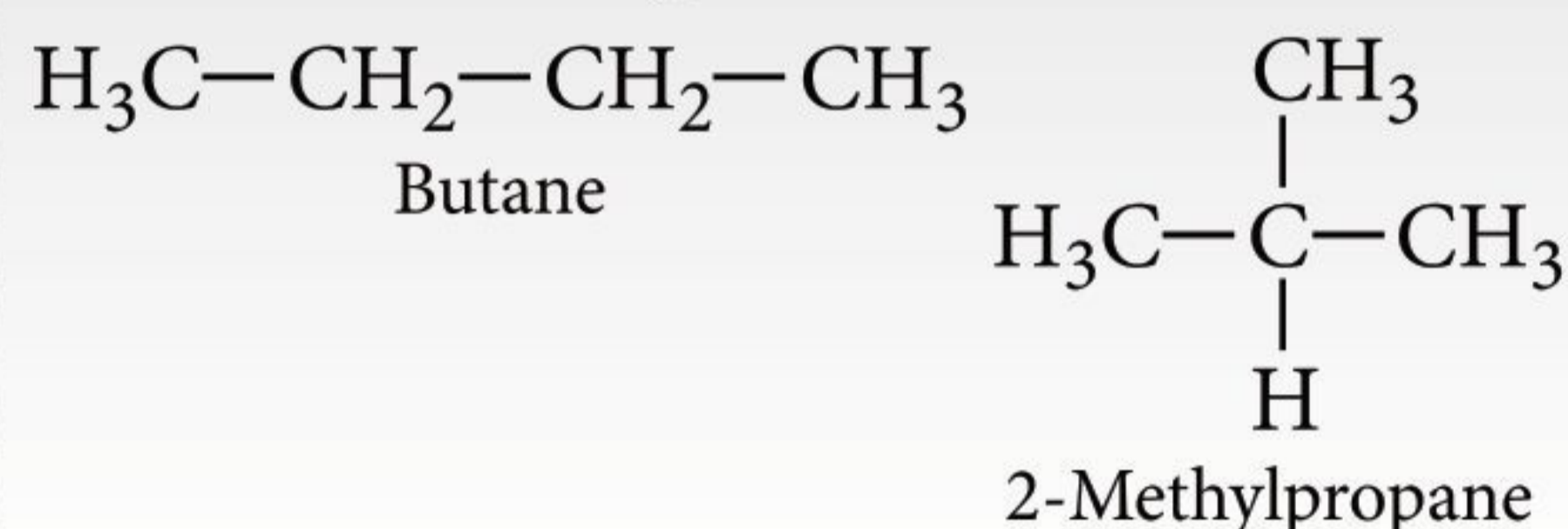
ISOMERISM

- The phenomenon of existence of two or more compounds possessing the same molecular formula but different properties is known as *isomerism*.
- Isomerism in an organic compound can be classified broadly into structural and stereoisomerism.

Structural Isomerism

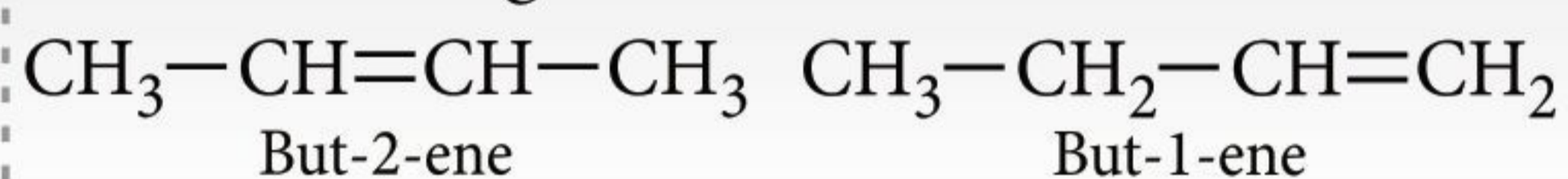
Chain isomerism

Different arrangement of carbon atoms in a carbon skeleton, *e.g.*,



Position isomerism

Different position of the same functional group in the molecule, *e.g.*,



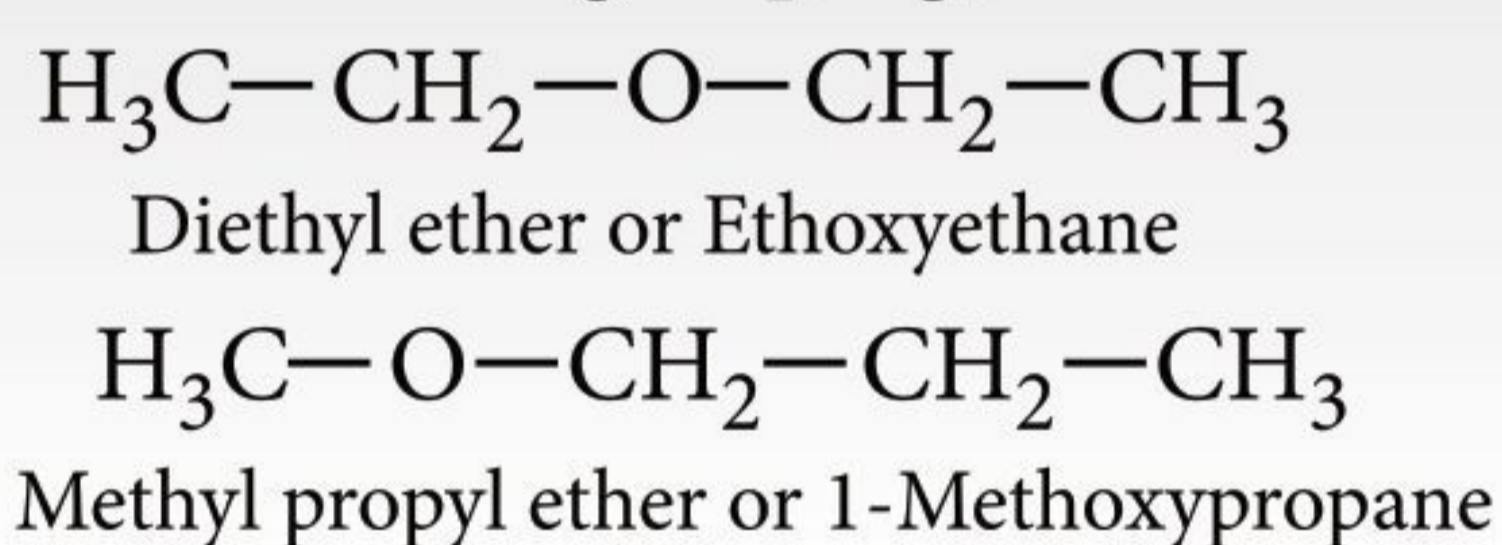
Functional isomerism

Different positions of atoms give different functional groups, *e.g.*,



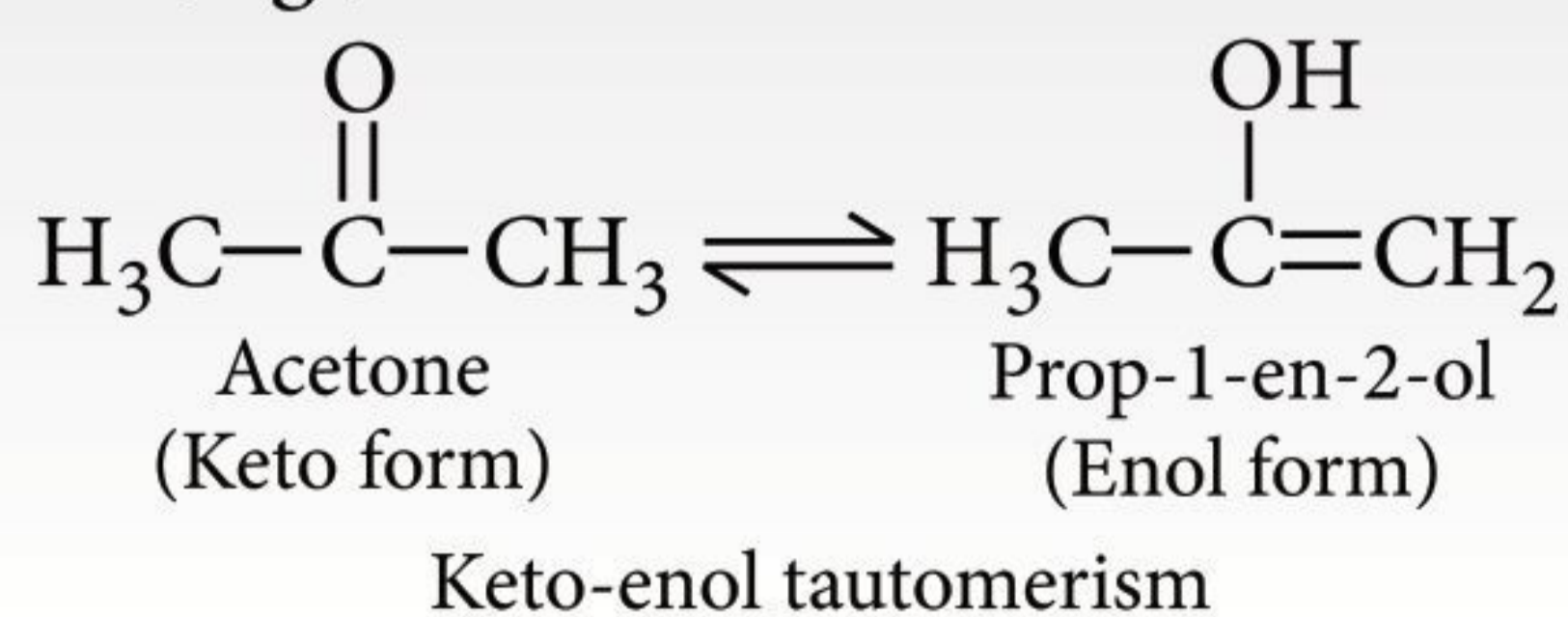
Metamerism

Different alkyl groups are attached to the same polyvalent functional group, *e.g.*,



Tautomerism

Tautomers have different functional groups and exist in dynamic equilibrium with each other due to a rapid interconversion from one form to another, *e.g.*,



Stereoisomerism

Geometrical isomerism

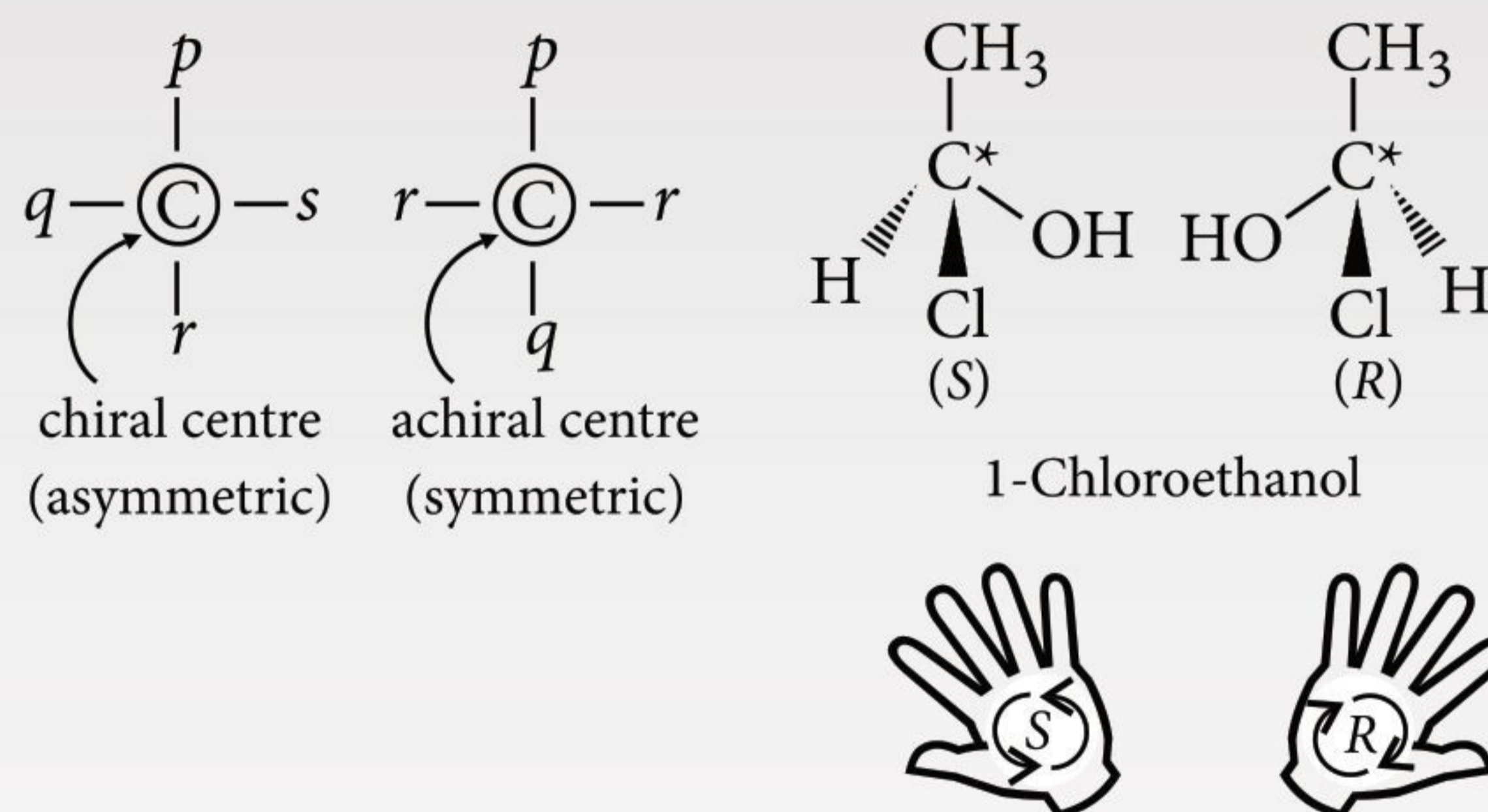
Different arrangement of substituents around a bond with restricted rotation. *e.g.*,



In addition to alkenes, compounds containing $\text{C}=\text{N}$ (aldoxime and ketoxime) and $\text{N}=\text{N}$ (azo compounds) bonds also show geometrical isomerism. However, in these cases, 'syn' (for *cis*) and 'anti' (for *trans*) are more commonly used.

Optical isomerism

- In order to exhibit optical activity, an object must be *chiral*.
- The compound is said to have *chirality* if the central carbon atom is attached to four different groups and this centre is called *chiral (asymmetric) centre* or *stereogenic centre* or *stereocentre*.

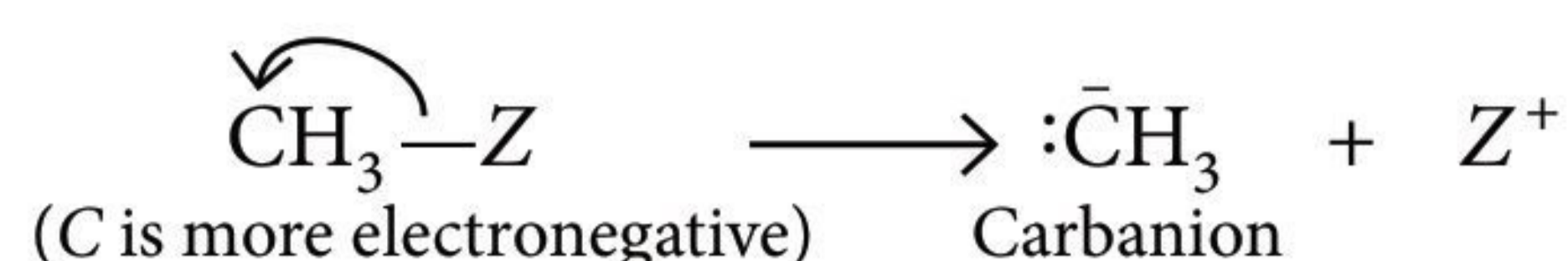
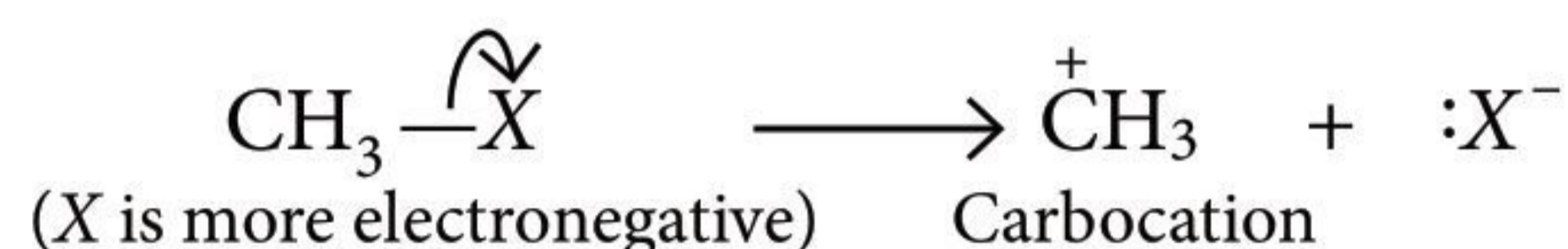


- *Enantiomers* or *d- and l-isomers* are the optical isomers which are non-superimposable mirror images (or dissymmetric) of each other.
- *Diastereomers* are the optical isomers which are not mirror images of each other. They have different physical properties and magnitude of specific rotation.
- *Meso* compounds are those compounds which have two or more even number of chiral carbon atoms and have an internal plane of symmetry. They are optically inactive due to *internal compensation*.

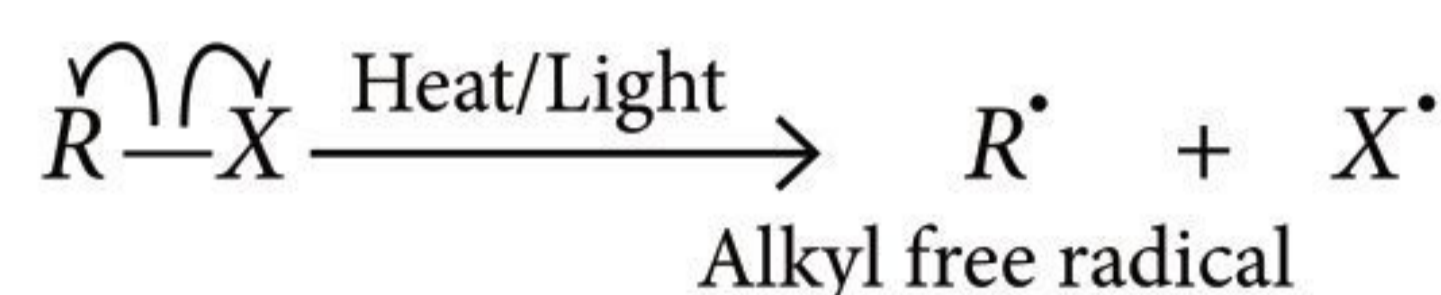
ELECTRONIC DISPLACEMENT IN A COVALENT BOND

Fission of a covalent bond :

- *Heterolytic cleavage* involves breaking of a covalent bond in such a fashion that the shared pair of electrons remains with one of the fragments, which results in the formation of carbocations or carbanions as intermediates.



- *Homolytic cleavage* involves breaking of a covalent bond in such a fashion that one of the electrons of the shared pair goes with each of the bonded atom, which results in the formation of free radicals as intermediates.



Attacking Reagents

Electrophiles	Nucleophiles	Ambiphiles
They are positively charged or neutral molecules having electron deficient atom, seeking a site of high electron density to attack. Electrophiles have incomplete outer shells and are also called <i>Lewis acids</i> (electron-pair acceptors). Charged : H_3O^+ , X^+ (where X = Cl, Br, I), NO_2^+ , NO^+ , SO_3H^+ , $\text{C}_6\text{H}_5\text{N}_2^+$, R^+ , RCO^+ . Neutral : BF_3 , AlCl_3 , FeCl_3 , SiCl_4 , BeCl_2 , ZnCl_2 , SO_3 , CO_2 , CS_2 , CX_4 , RCOCl , $>\text{C}=\text{O}$, $:\text{CCl}_2$.	They are negatively charged or neutral molecules having electron-rich atom with unshared electron pair, seeking electron deficient site to attack. They are also called <i>Lewis bases</i> (electron-pair donors). Charged : H^- , OH^- , X^- , CN^- , N_3^- , RO^- , R^- , RS^- , SH^- , HSO_3^- , NO_2^- , NH_2^- , RCOO^- , $\text{HC}\equiv\text{C}^-$. Neutral : $\ddot{\text{N}}\text{H}_3$, $\text{H}_2\ddot{\text{O}}$, $\text{R}\ddot{\text{O}}\text{H}$, $\text{R}\ddot{\text{O}}\text{R}$, $\text{R}\ddot{\text{S}}\text{H}$, RMgX , $\text{Ph}_3\ddot{\text{P}}$, RLi , LiAlH_4 , etc.	They behave both like electrophiles and nucleophiles hence, have dual nature. $\text{R}\ddot{\text{O}}\text{H}$, $\text{H}\ddot{\text{O}}\text{H}$ and $\text{R}\ddot{\text{P}}\text{H}_2$

Electron displacement effects in covalent bonds

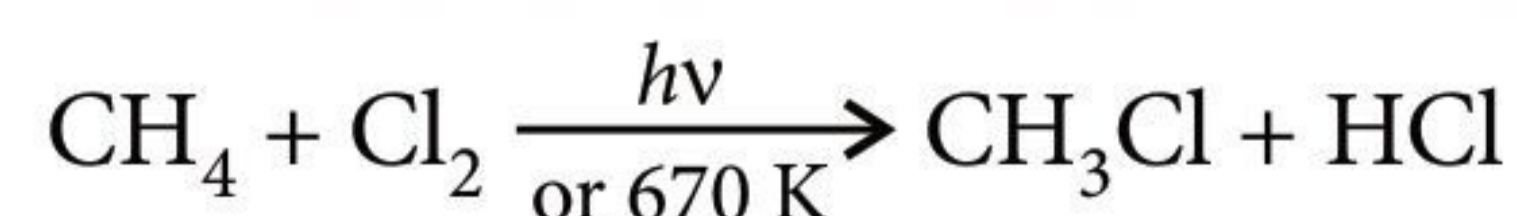
- *Inductive effect* : Displacement of σ -electrons along a saturated carbon chain when an electron donating (+I effect) or electron withdrawing (–I effect) group is attached at the end of the carbon chain.
 - Decreasing order of –I effect : $-\text{NO}_2 > -\text{CN} > -\text{COOH} > -\text{F} > -\text{Cl} > -\text{Br} > -\text{I} > -\text{H}$
 - Decreasing order of +I effect : $(\text{CH}_3)_3\text{C}- > (\text{CH}_3)_2\text{CH}- > \text{CH}_3\text{CH}_2- > \text{CH}_3- > \text{D}- > \text{H}-$
- *Electromeric effect* : It involves complete transfer of π electrons of a multiple bond towards one of the bonded atoms in the presence of an attacking reagent. It is a temporary effect.
 - +E effect : When electron transfer takes place towards the atom to which the attacking reagent gets attached.
 - –E effect : When electron transfer takes place away from the atom to which the attacking reagent gets attached.

- *Resonance or Mesomeric effect* : It is defined as the polarity produced in the molecule by the interaction of two π bonds or between a π bond and a lone pair of electrons present on adjacent atom.
 - +R or +M effect : $-\text{OH}$, $-\text{OR}$, $-\text{SH}$, $-\text{SR}$, $-\text{NH}_2$, $-\text{NHR}$, $-\text{NR}_2$, $-\text{Cl}$, $-\text{Br}$, $-\text{I}$, etc.
 - –R or –M effect : $>\text{C}=\text{O}$, $-\text{CHO}$, $-\text{COOR}$, $-\text{CN}$, $-\text{NO}_2$, etc.
- *Hyperconjugation* : It involves delocalisation of σ electrons of C–H bond of an alkyl group directly attached to an atom of unsaturated system or to an atom with an unshared p-orbital. For an alkyl group attached to unsaturated system it decreases with decrease in number of α -hydrogens :
 $\text{CH}_3- > \text{CH}_3\text{CH}_2- > (\text{CH}_3)_2\text{CH}- > (\text{CH}_3)_3\text{C}-$

REACTIONS AND REACTION INTERMEDIATES

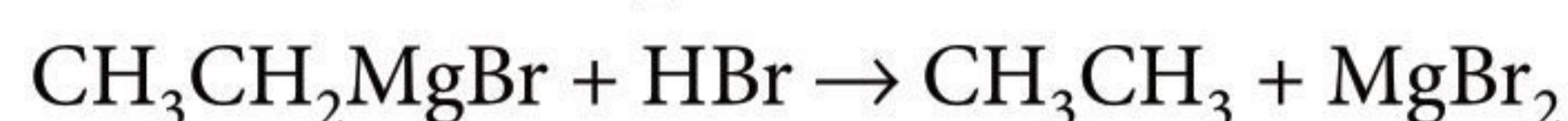
Substitution reactions

- Free radical substitution reaction

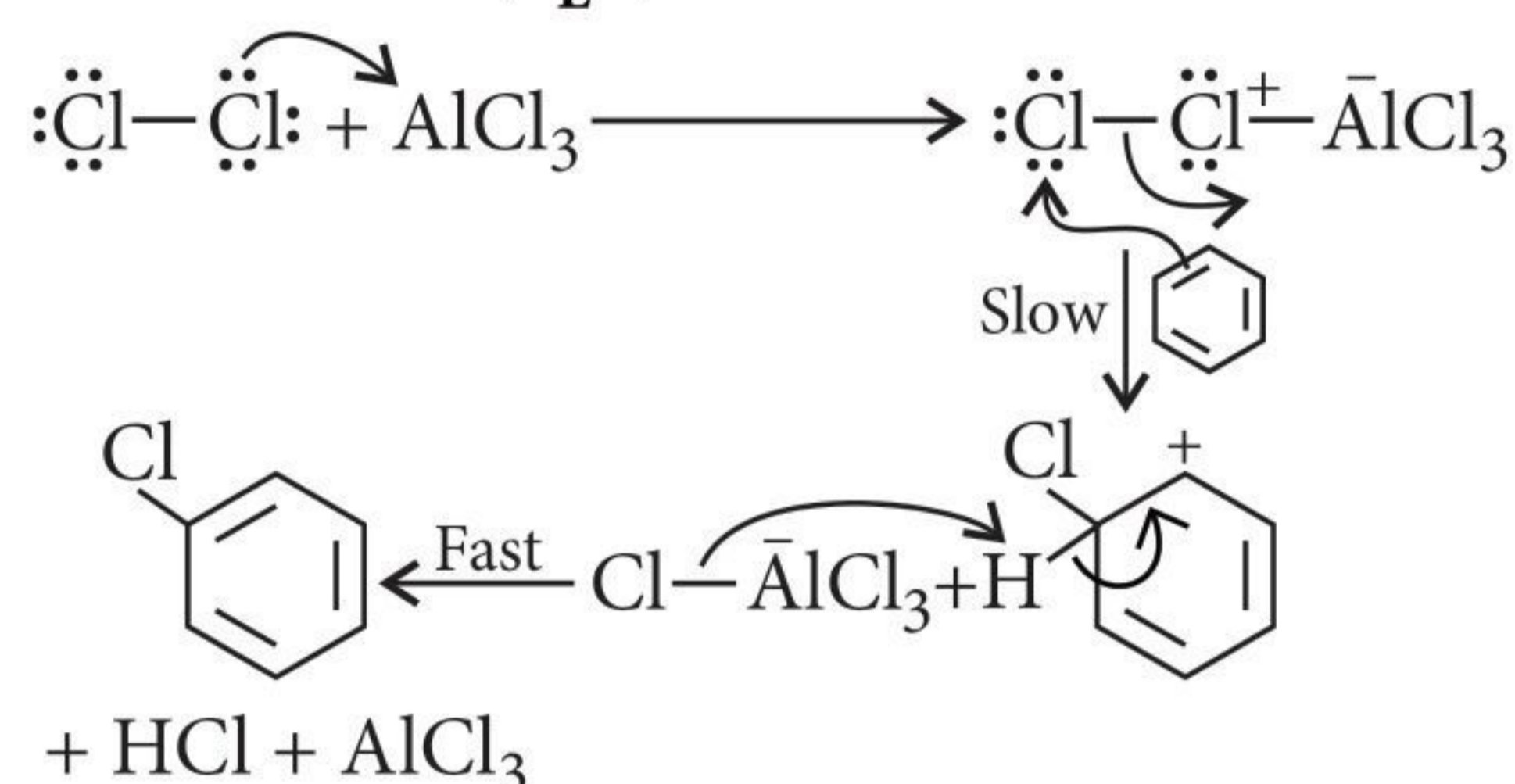


– **Electrophilic substitution reaction (S_E)**

– **Unimolecular (S_E1)**

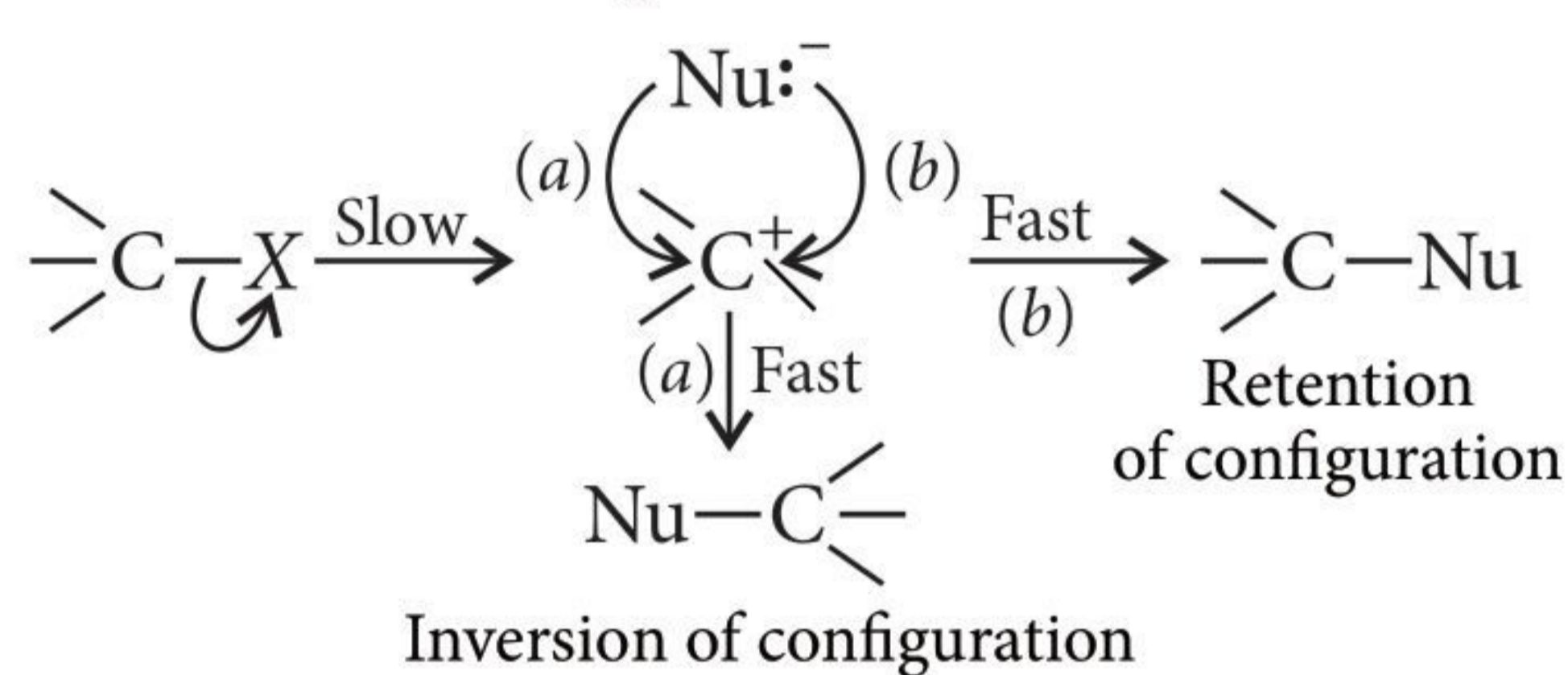


– **Bimolecular (S_E2)**

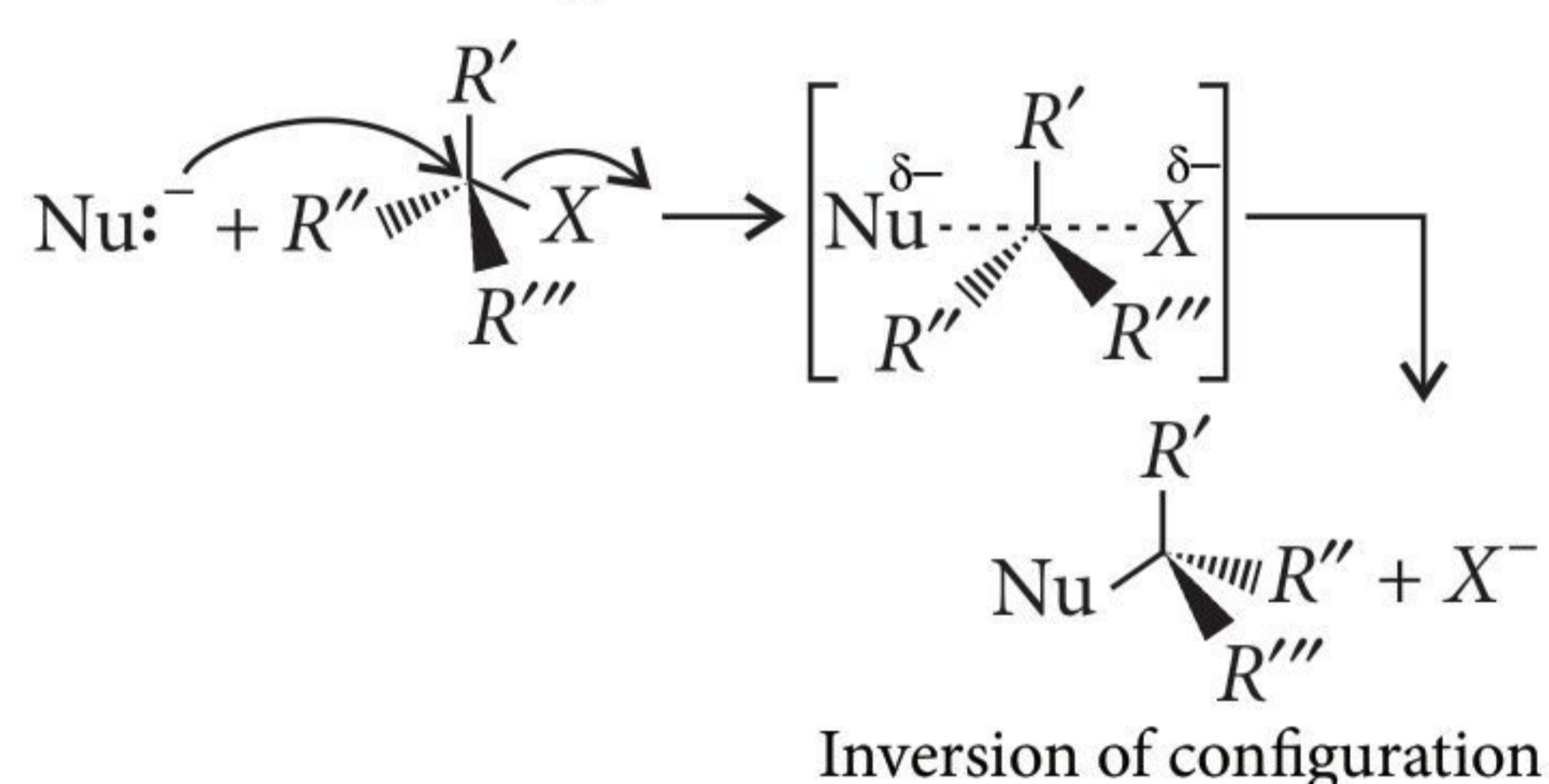


– **Nucleophilic substitution reaction (S_N)**

– **Unimolecular (S_N1)**

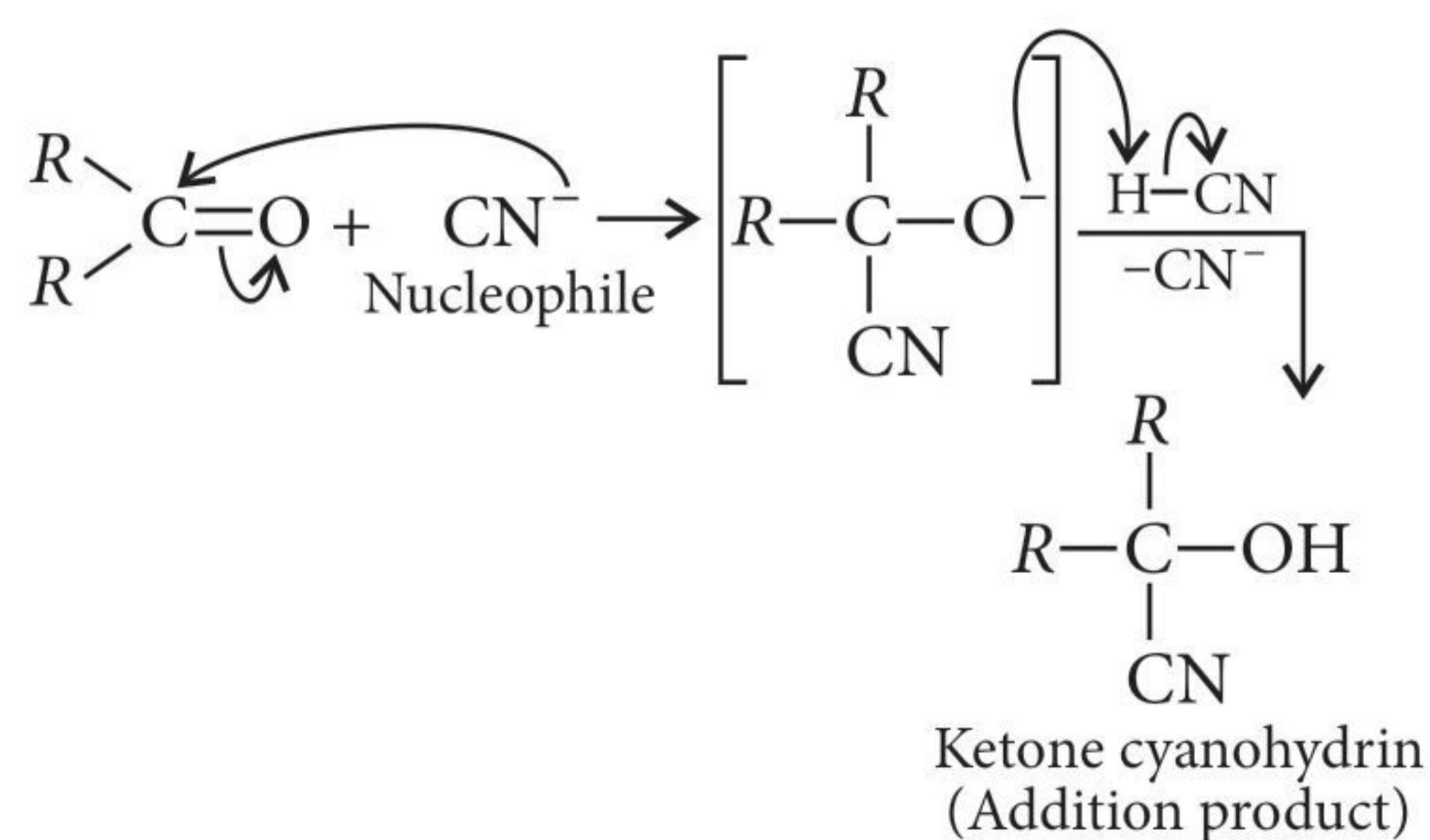
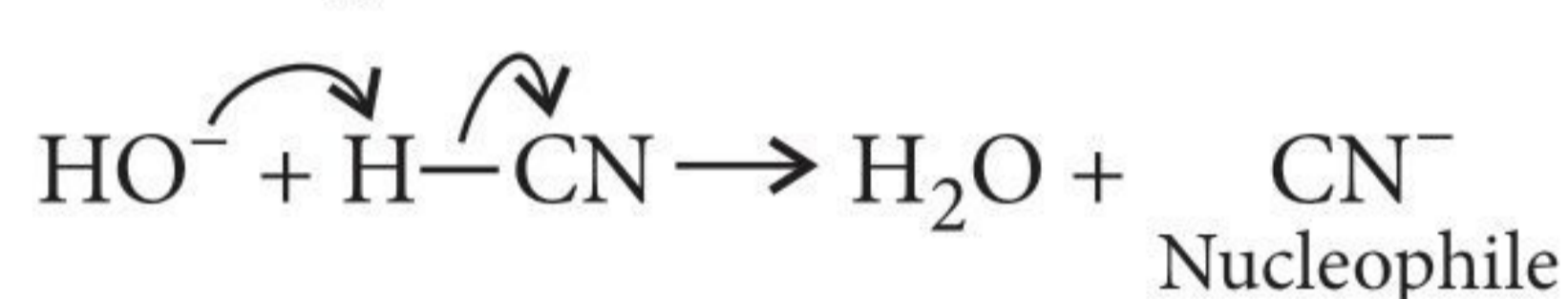


– **Bimolecular (S_N2)**

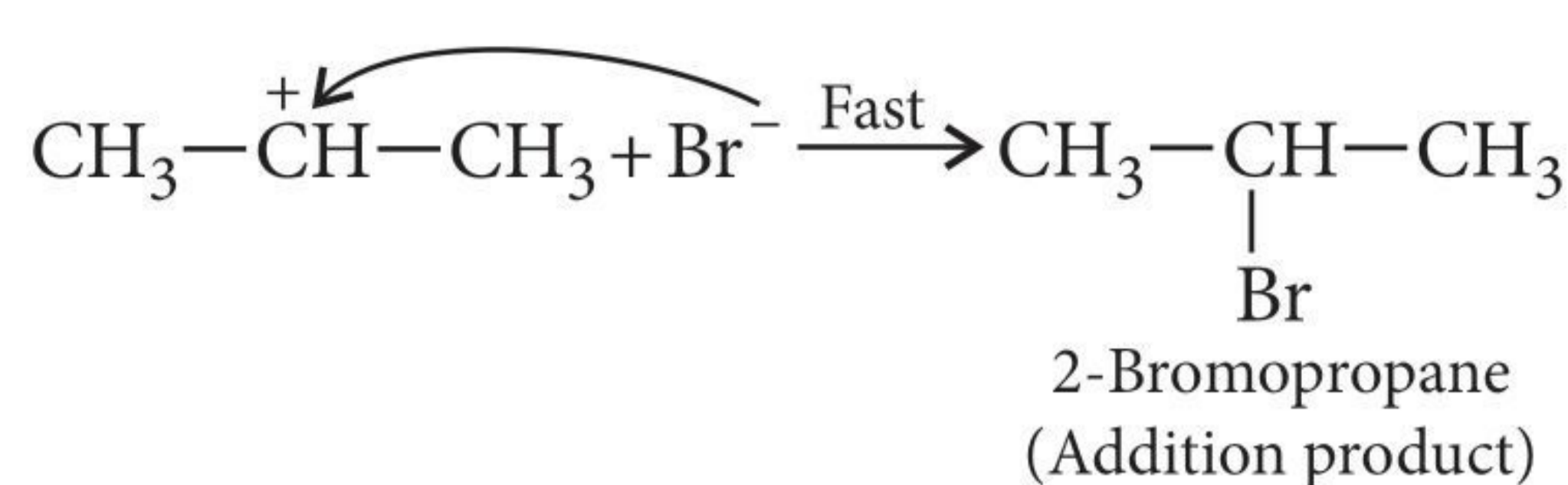
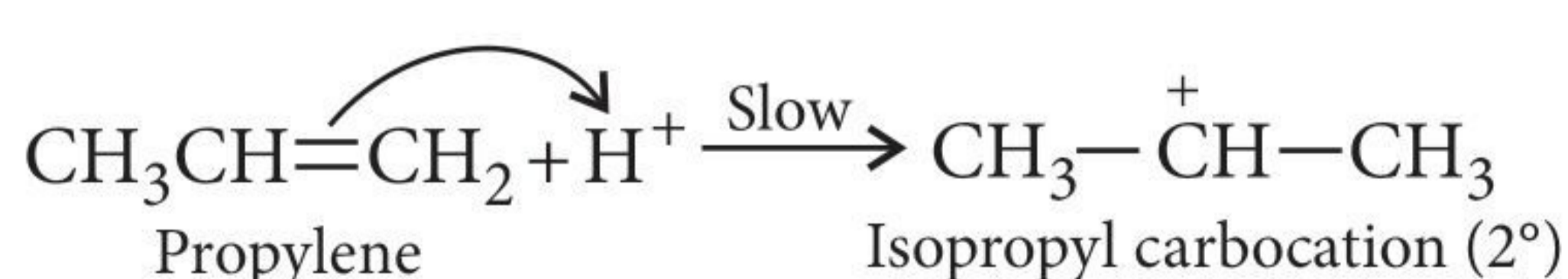


• **Addition reactions**

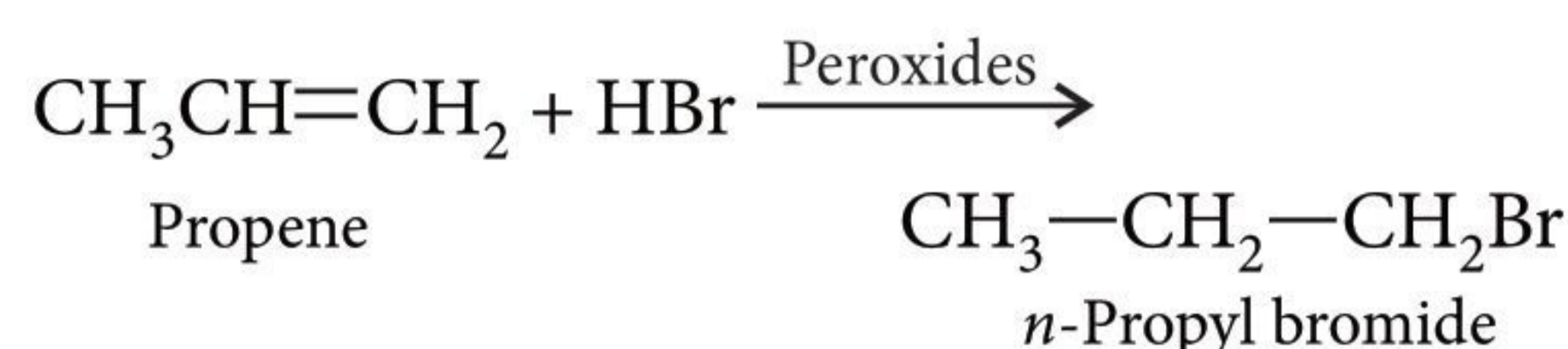
– **Nucleophilic addition reaction**



– **Electrophilic addition reaction**

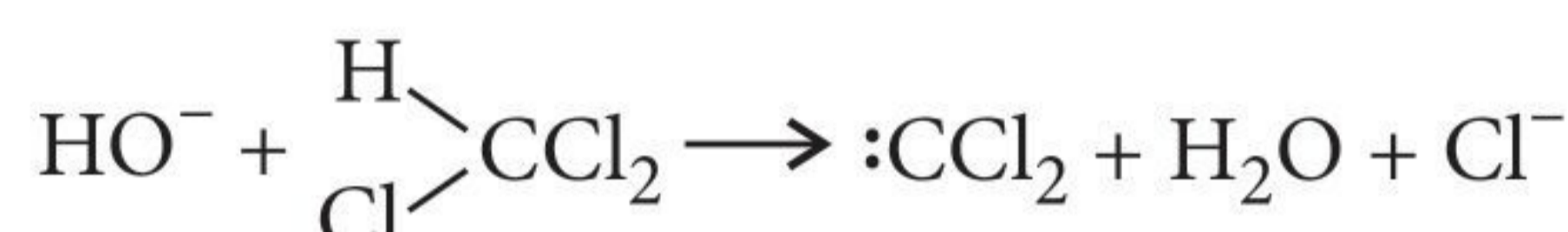


– **Free radical addition reaction**

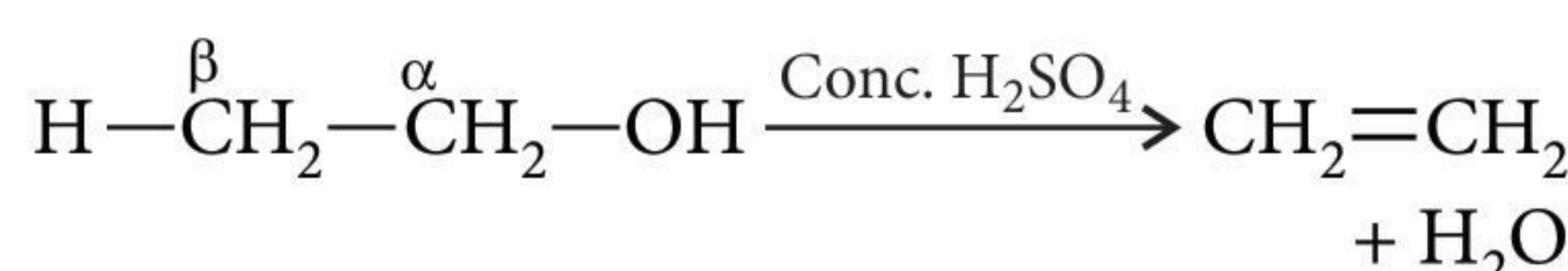


• **Elimination reactions**

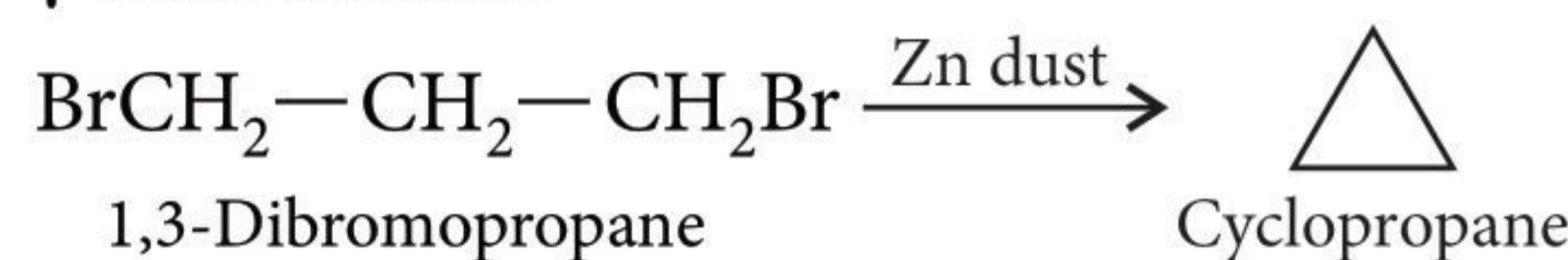
– **α-Elimination**



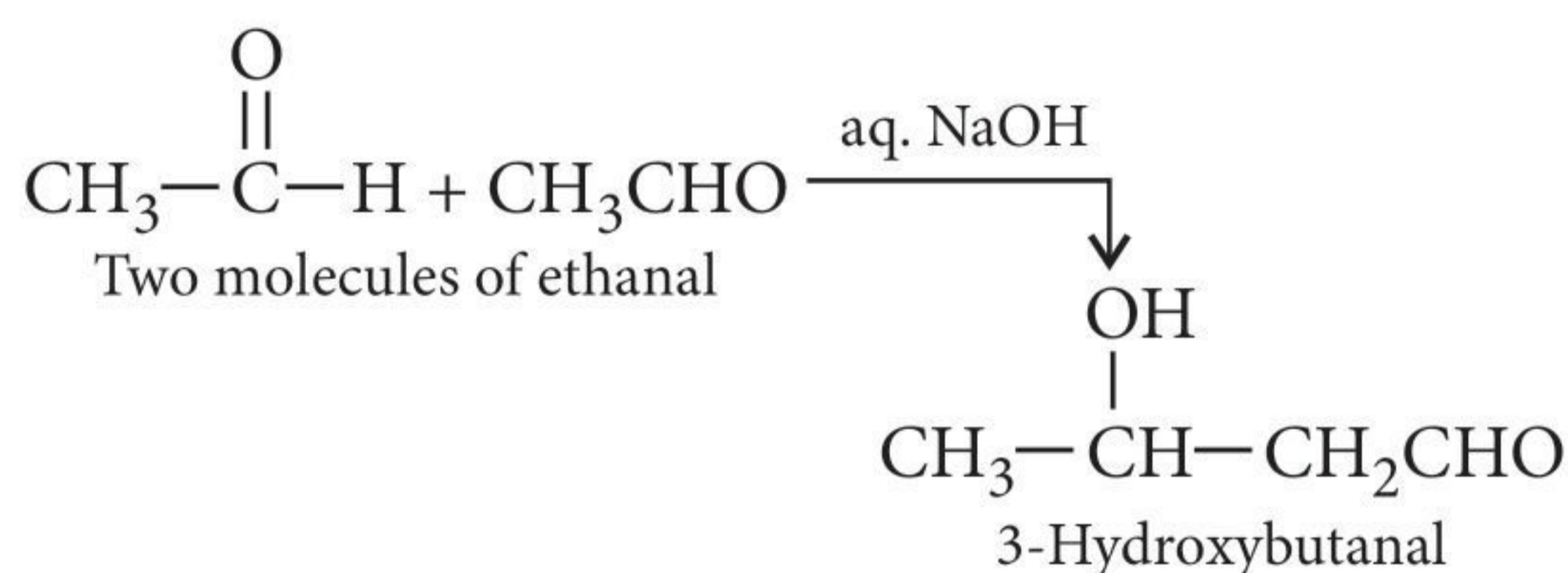
– **β-Elimination**



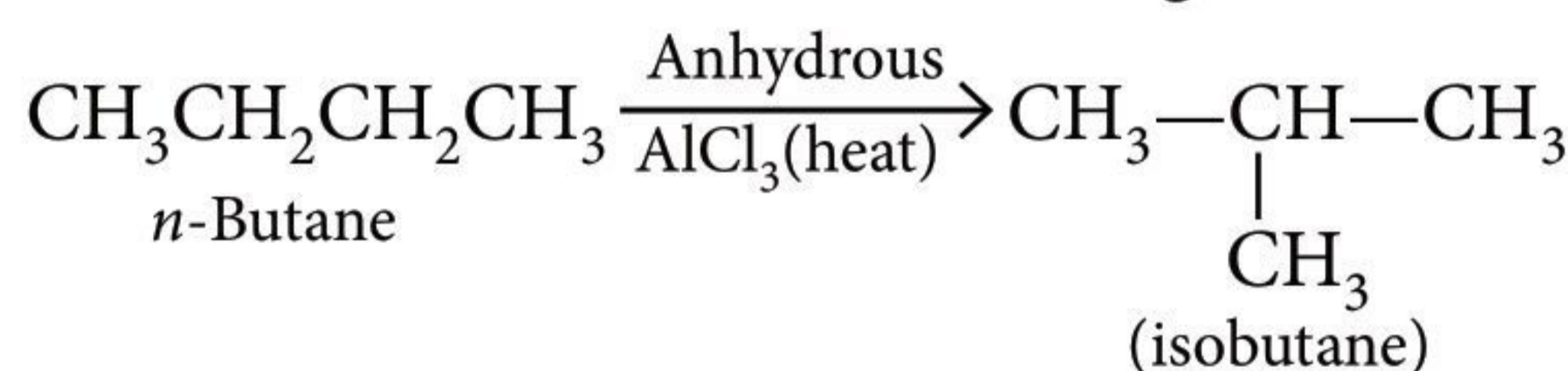
– **γ-Elimination**



• **Condensation reaction**



• **Isomerisation reaction or Rearrangement reaction**



PURIFICATION

- The organic compounds extracted from natural sources or synthesised in the laboratory are contaminated with small amounts of other similar compounds. In order to characterise them, it is essential to purify them.
- The methods employed for purification depend upon the nature of the substance (whether solid or liquid) and the type of impurities present in it.
- The purity of an organic compound is checked by determining one or more of its physical constants like melting point, boiling point etc.

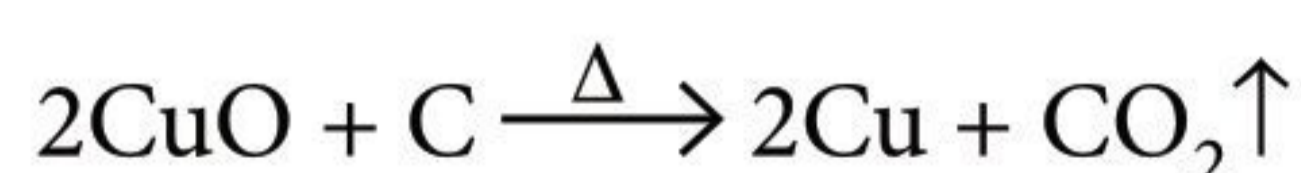
- The methods commonly used for purification are :

Method	Used for separating	Examples
Crystallisation	Mixtures with difference in the solubility of the organic compound and its impurities in a solvent.	<ul style="list-style-type: none"> Sugar with impurity of common salt can be crystallised from hot ethanol (sugar dissolves but salt does not). Benzoic acid and naphthalene from hot water (benzoic acid dissolves but naphthalene does not).
Sublimation	Mixtures of sublimable volatile compounds and non-sublimable impurities.	<ul style="list-style-type: none"> Purification of camphor, anthracene, naphthalene, benzoic acid, etc.
Distillation	Mixtures of liquids which boil without decomposition and contains non-volatile impurities.	<ul style="list-style-type: none"> Chloroform (b.pt. 334 K) and aniline (b.pt. 457 K). Ether (b.pt. 308 K) and toluene (b.pt. 383 K).
Fractional distillation	Mixtures of two or more miscible liquids which have b.pt. close to each other.	<ul style="list-style-type: none"> Acetone (b.pt. 330 K) and methyl alcohol (b.pt. 338 K). Benzene (b.pt. 353 K) and toluene (b.pt. 383 K).
Steam distillation	Mixtures of substances which are (i) volatile in steam, (ii) not miscible with water, (iii) possess a vapour pressure of about 10-15 mm of Hg, (iv) contain non-volatile impurities.	<ul style="list-style-type: none"> Purification of aniline (b.pt. 457 K). Nitrobenzene, <i>o</i>-nitrophenol, bromobenzene, etc.
Azeotropic distillation	Mixtures with constant boiling points-azeotropic mixtures.	<ul style="list-style-type: none"> Ethanol and water in ratio 95.87 : 4.13
Vacuum distillation	Mixtures of high boiling liquids which decompose at or below their boiling points.	<ul style="list-style-type: none"> Glycerol from spent-lye in soap industry (at 453 K under 12 mm Hg). Concentration of sugarcane juice.
Chromatography	Mixtures with difference in the rates at which the components of the mixture move through a porous medium.	<ul style="list-style-type: none"> <i>ortho</i> and <i>para</i>-nitroanilines. Blue and red dyes. Plant pigments and other natural products.
Differential extraction	Mixtures of organic compounds from their aqueous solutions using a solvent that should (i) be immiscible with water, (ii) dissolve the organic compound.	<ul style="list-style-type: none"> Benzoic acid from its water solution using benzene.

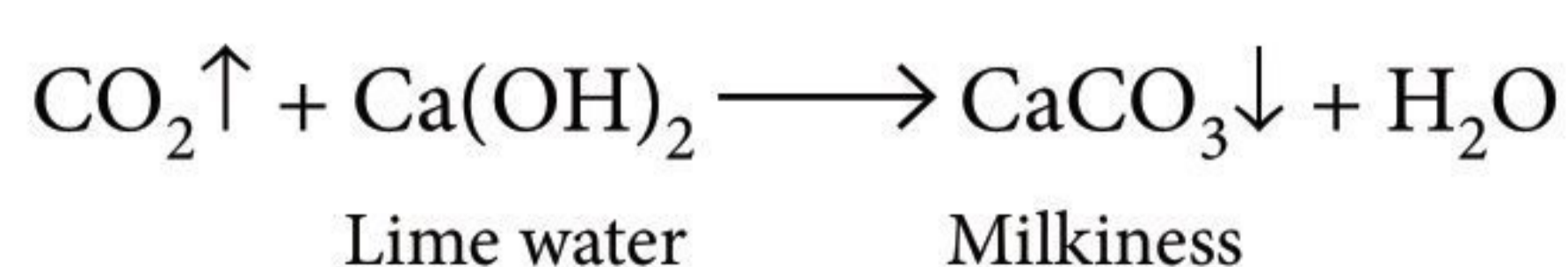
QUALITATIVE ANALYSIS

Detection of Elements and their Confirmatory Tests

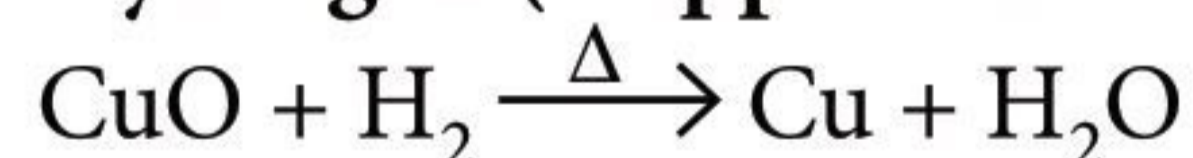
- Carbon (Copper oxide test)**



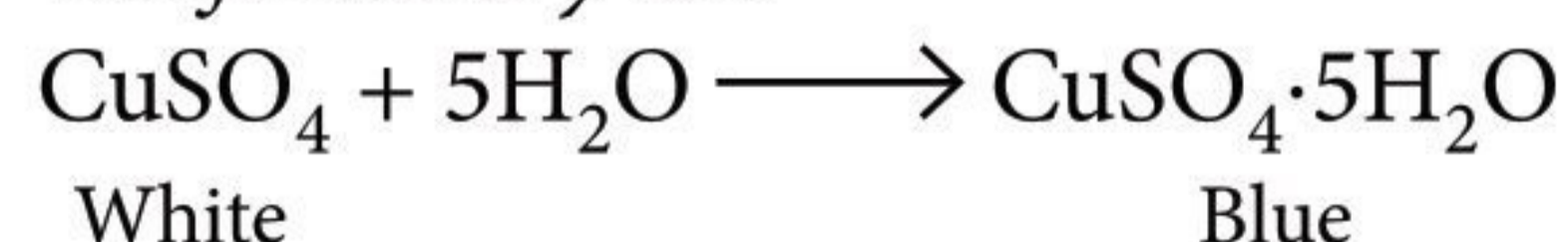
Confirmatory test



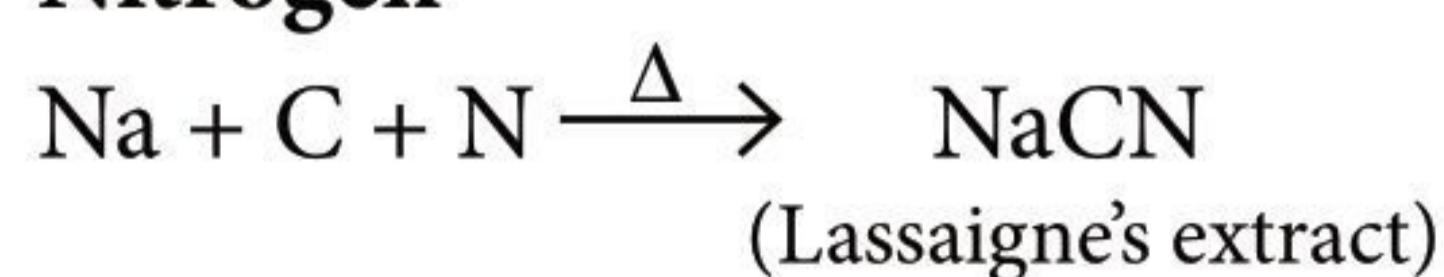
- Hydrogen (Copper oxide test)**



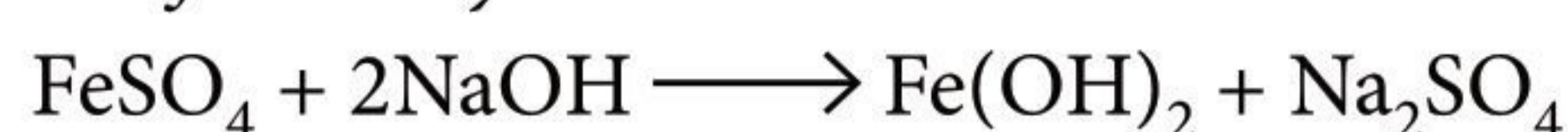
Confirmatory test

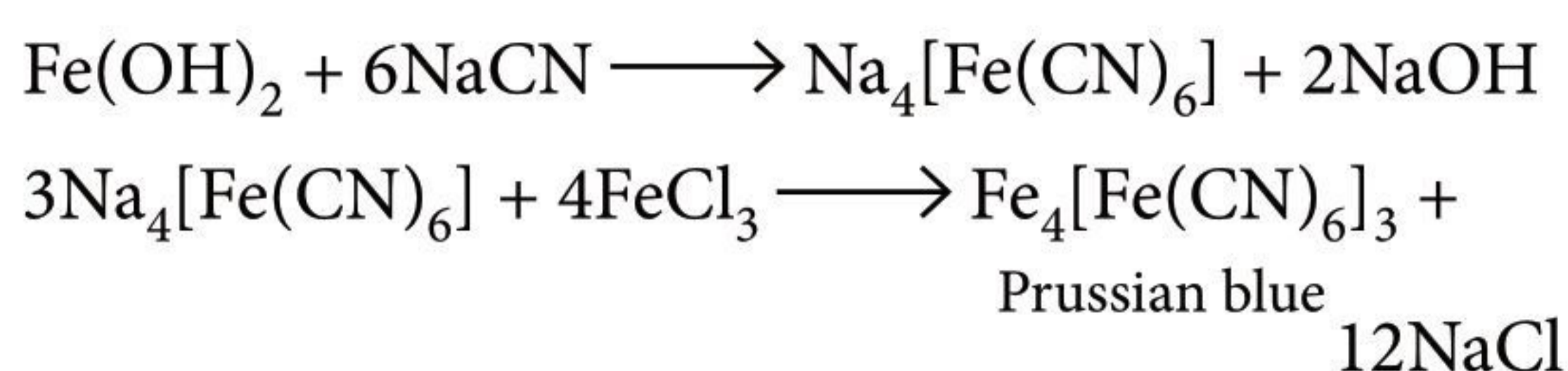


- Nitrogen**

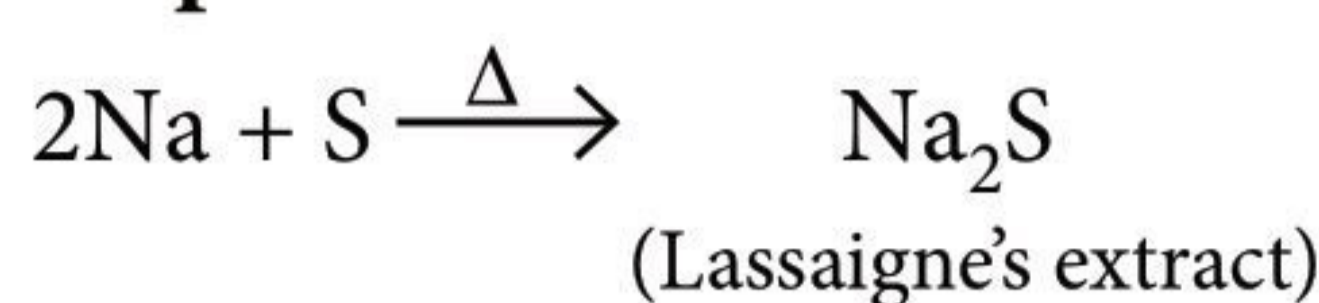


Confirmatory test

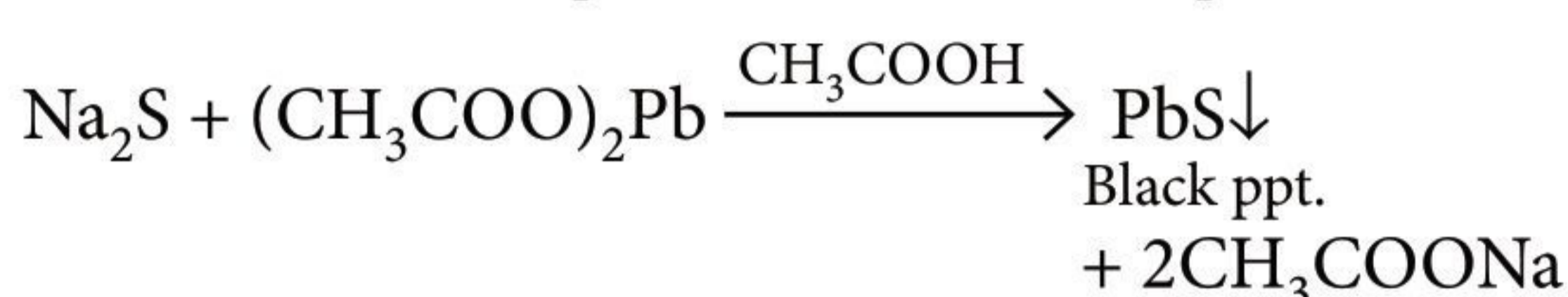
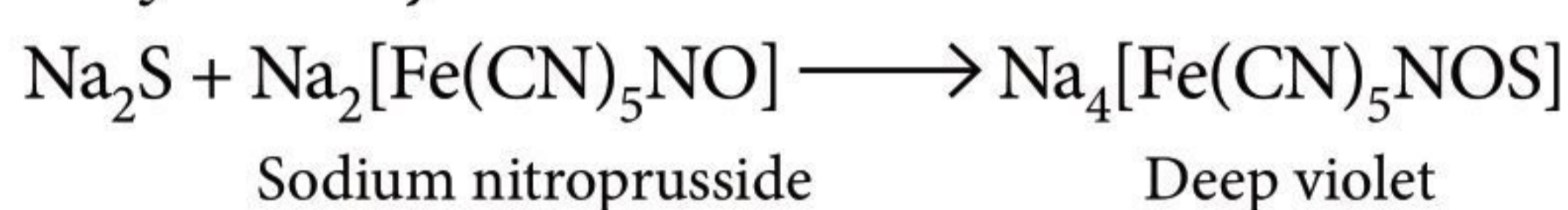




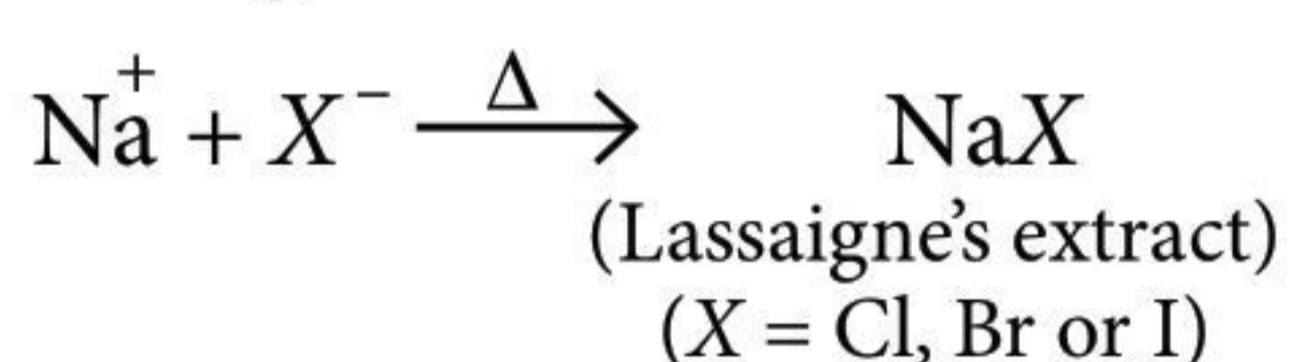
• Sulphur



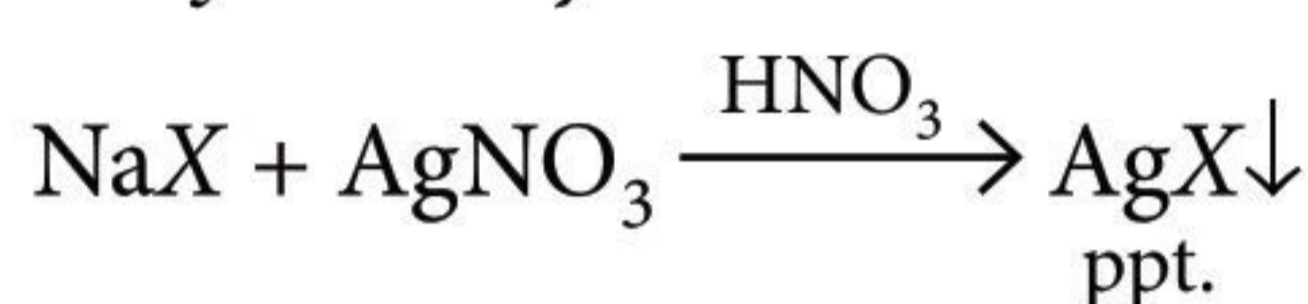
Confirmatory test



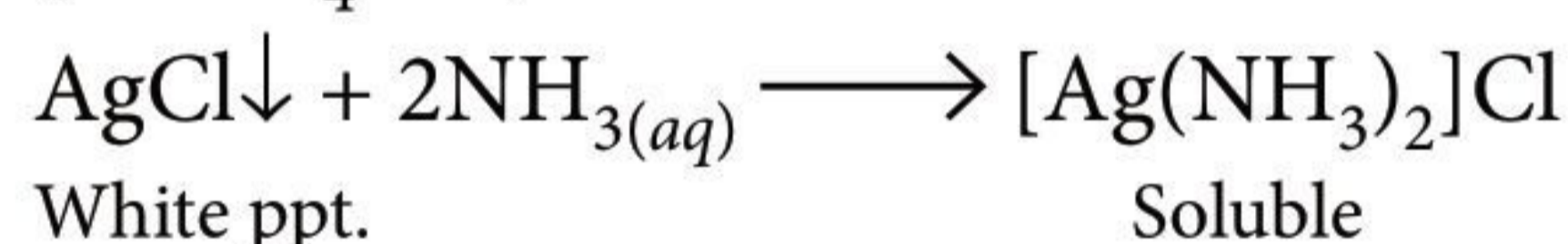
• Halogens



Confirmatory test

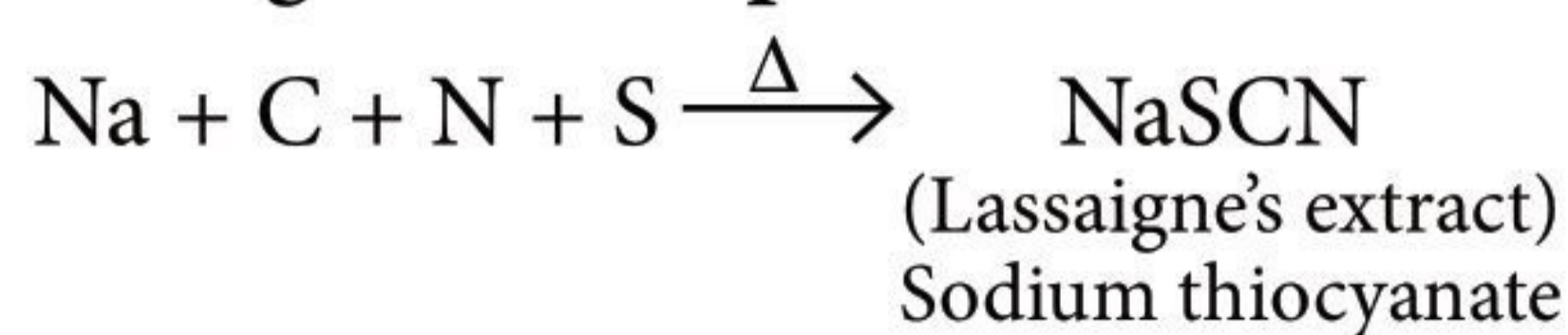


- White ppt. soluble in aqueous NH_3 (or NH_4OH) confirms Cl^- .

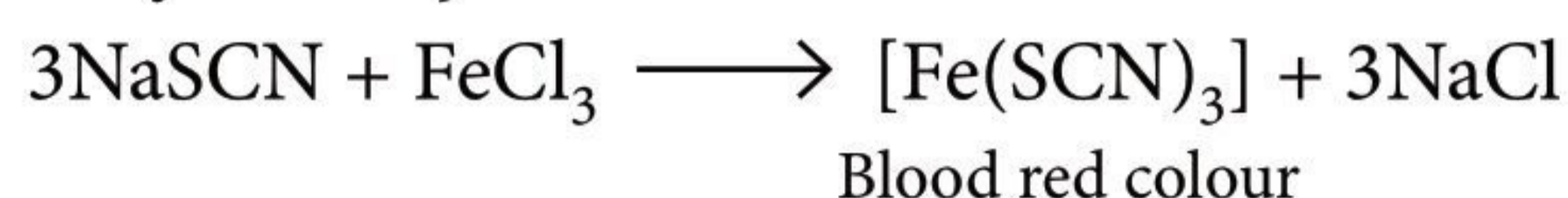


- Yellow ppt. partially soluble in aqueous NH_3 (or NH_4OH) confirms Br.
- Yellow ppt. insoluble in aqueous NH_3 (or NH_4OH) confirms I.

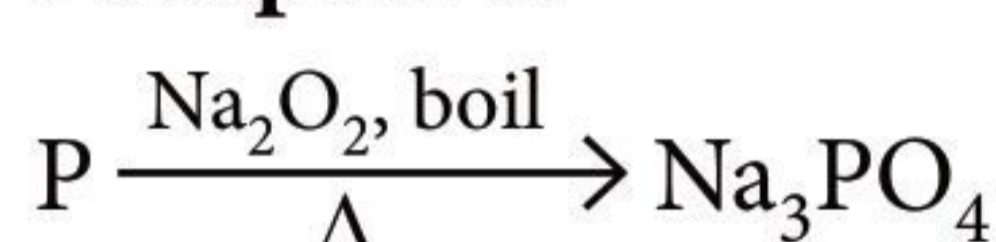
• Nitrogen and sulphur both in one compound



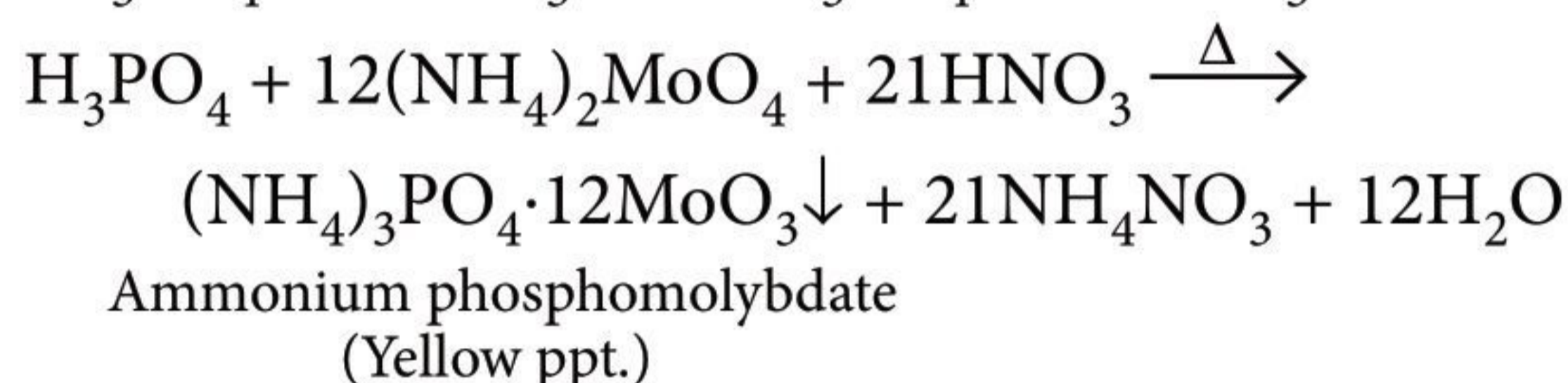
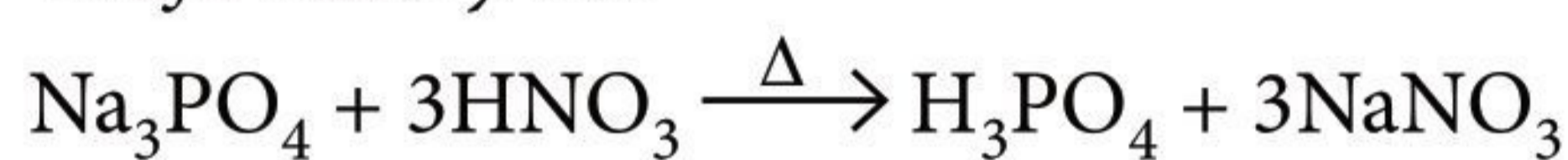
Confirmatory test



• Phosphorus



Confirmatory test



QUANTITATIVE ANALYSIS

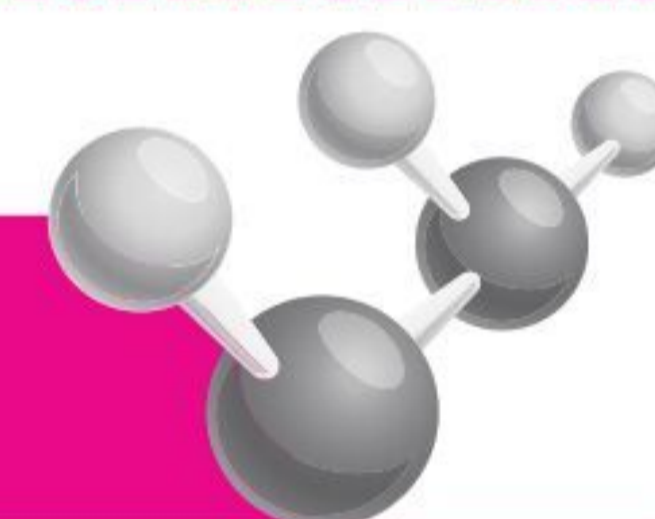
- The percentage composition of elements present in an organic compound is determined by the following methods :

Element	Method	Process	Formula
Carbon and Hydrogen	Leibig's combustion method	A known weight of the organic compound (w g) is combusted with excess of O_2 and amount of CO_2 and H_2O formed are used to determine percentage of C and H. $\text{C}_x\text{H}_y + \left(x + \frac{y}{4}\right)\text{O}_2 \xrightarrow{\Delta} x\text{CO}_2 + \frac{y}{2}\text{H}_2\text{O}$	(i) $\begin{array}{ccc} \text{C} & \longrightarrow & \text{CO}_2 \\ 12 \text{ g} & & 44 \text{ g} \end{array}$ $\%C = \frac{12 \times \text{wt. of CO}_2 \times 100}{44 \times w}$ (ii) $\begin{array}{ccc} 2\text{H} & \longrightarrow & \text{H}_2\text{O} \\ 2 \text{ g} & & 18 \text{ g} \end{array}$ $\%H = \frac{2 \times \text{wt. of H}_2\text{O} \times 100}{18 \times w}$
Nitrogen	(i) Dumas method	Elemental nitrogen in organic compound (w g) is converted into molecular nitrogen by suitable chemical method and its volume is changed to S.T.P. data. $\text{C}_x\text{H}_y\text{N}_z + \left(2x + \frac{y}{2}\right)\text{CuO} \xrightarrow{\Delta} x\text{CO}_2 + \frac{y}{2}\text{H}_2\text{O} + \frac{z}{2}\text{N}_2 + \left(2x + \frac{y}{2}\right)\text{Cu}$	$2\text{N} \longrightarrow \text{N}_2(\text{g})$ $\begin{array}{ccc} 28 \text{ g} & & 22.4 \text{ L at S.T.P.} \end{array}$ $\%N = \frac{28 \times V \times 100}{22.4 \times w}$ where V is the volume of N_2 gas in L at S.T.P
	(ii) Kjeldahl's method	Nitrogen in the organic compound (w g) is converted into NH_3 by suitable chemical method which, in turn, is absorbed by V_1 mL of N_1 H_2SO_4 . $\text{Organic compound} \xrightarrow[\Delta]{\text{H}_2\text{SO}_4} (\text{NH}_4)_2\text{SO}_4 \xrightarrow[\Delta]{2\text{NaOH}} 2\text{NH}_3 \xrightarrow{\text{H}_2\text{SO}_4} (\text{NH}_4)_2\text{SO}_4$	$2\text{N} \longrightarrow \text{NH}_3 \approx \text{H}_2\text{SO}_4$ $\%N = \frac{1.4 \times N_1 \times V_1}{w}$

Sulphur	Carius method	<p>Sulphur in the organic compound (w g) is converted into H_2SO_4 by boiling with conc. HNO_3 and is precipitated as BaSO_4.</p> $\text{S} \xrightarrow[\text{(ii) BaCl}_2]{\text{(i) HNO}_3, \Delta} \text{BaSO}_4 \downarrow$ <p style="text-align: center;">white ppt.</p>	$\text{S} \longrightarrow \text{H}_2\text{SO}_4 \longrightarrow \text{BaSO}_4$ $32 \text{ g} \qquad\qquad\qquad 233 \text{ g}$ $\% \text{S} = \frac{32 \times \text{wt. of BaSO}_4 \times 100}{233 \times w}$
Halogen	Carius method	<p>Halogen in the organic compound (w g) is precipitated as silver halide by boiling with conc. HNO_3 and then adding AgNO_3.</p>	$\text{Cl}^- \longrightarrow \text{AgCl}$ $35.5 \text{ g} \qquad\qquad\qquad 143.5 \text{ g}$ $\% \text{Cl} = \frac{35.5 \times \text{wt. of AgCl} \times 100}{143.5 \times w}$
Phosphorus	Ignition method	<p>Phosphorus in organic compound (w g) is precipitated as magnesium ammonium phosphate by sequential reaction with nitric acid, MgCl_2 and mixture of $\text{NH}_4\text{Cl} + \text{NH}_4\text{OH}$ and then the precipitate is ignited to form magnesium pyrophosphate.</p>	$\text{Mg}_2\text{P}_2\text{O}_7 \longrightarrow 2\text{P}$ $222 \text{ g} \qquad\qquad\qquad 62 \text{ g}$ $\% \text{P} = \frac{\text{Mass of Phosphorus}}{\text{Mass of organic compound}} \times 100$ $= \frac{62 \times \text{wt. of Mg}_2\text{P}_2\text{O}_7 \times 100}{222 \times w}$
Oxygen			$\% \text{O} = 100 - \text{Sum of the percentages of other elements}$



3 Amazing Facts You Must Know



1. Air becomes liquid at -190°C :

Commonly, matter appears in one of the four states: solid, liquid, gas and plasma. The air we all breathe is gaseous but like any kind of matter, it can change its state when subjected to certain temperature and pressure. Air is a mixture of nitrogen, oxygen, and other gases. The gas can be liquefied by compression and cooling to extremely low temperatures — under normal atmospheric pressure, air has to be cooled to -200°C and under high pressure (typically 200 atmospheres) to -141°C to convert into liquid. Liquid air is used commercially for freezing other substances and especially as an intermediate step in the production of nitrogen, oxygen, and argon and the other inert gases.



2. Thirsty? You're already dehydrated :

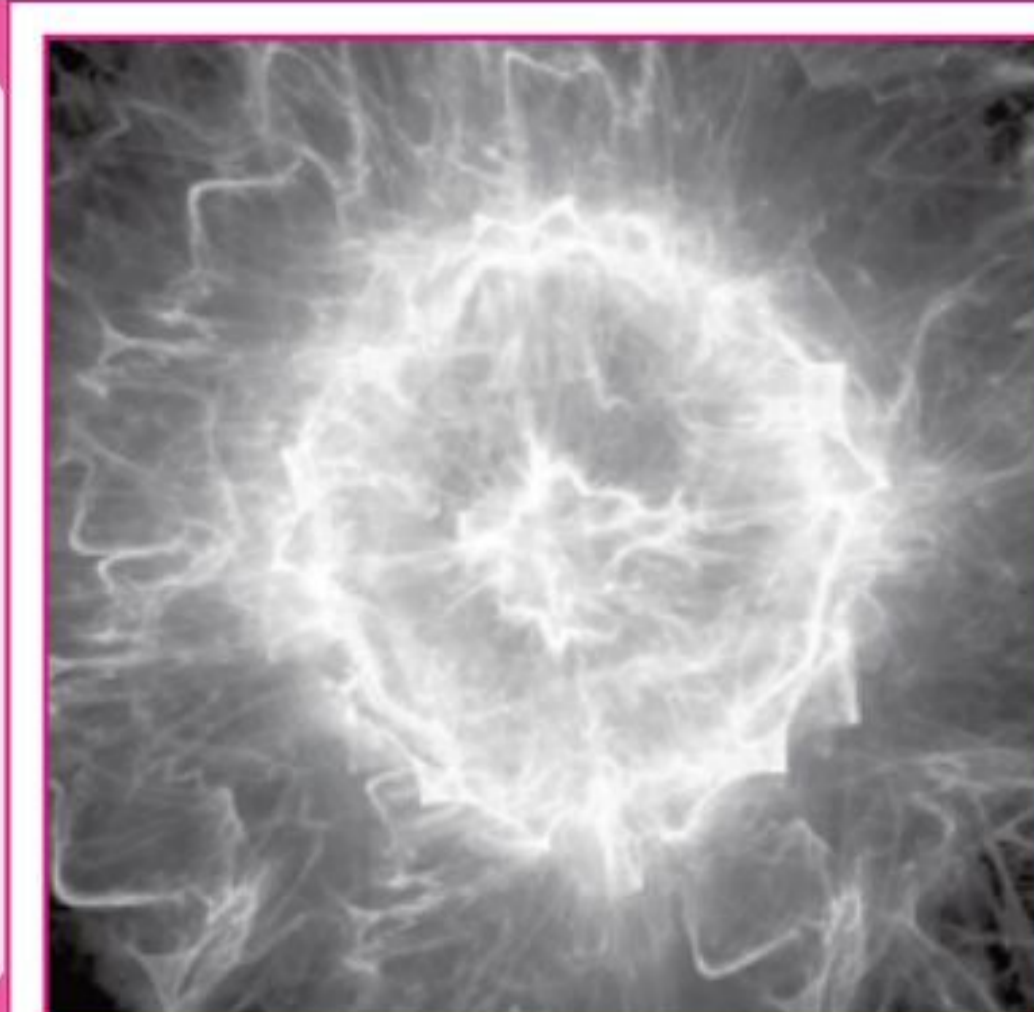
Summertime means lots of people are outside dealing with the heat — some by choice and some because they have to. Whatever the reason, staying hydrated is the key to dealing with hotter temperatures, said a Medicine physician. "The rule of thumb is, if you're thirsty, you're already dehydrated. So keep well hydrated by drinking plenty of water, even before you begin your outdoor activity," said, a primary care sports medicine physician. This applies to people who workout or play sports outdoors as well as those whose jobs keep them outside day in and day out, like electricians and yard maintenance workers. When the body becomes dehydrated, it works to retain fluids lost through sweating by decreasing urinary output. Constipation also can result as the body works to retain water. Dehydration also involves the cardiovascular system, resulting in decreased blood pressure and increased pulse.

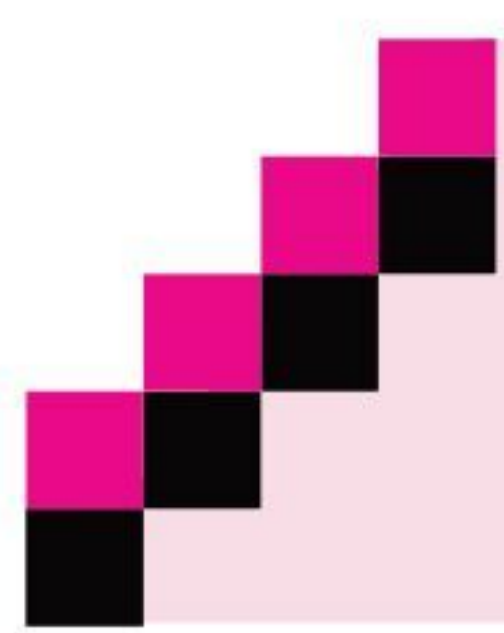
"When you feel thirsty, you are already dehydrated."



3. The most valuable substance on earth, 1g worth 25 Billion Dollars :

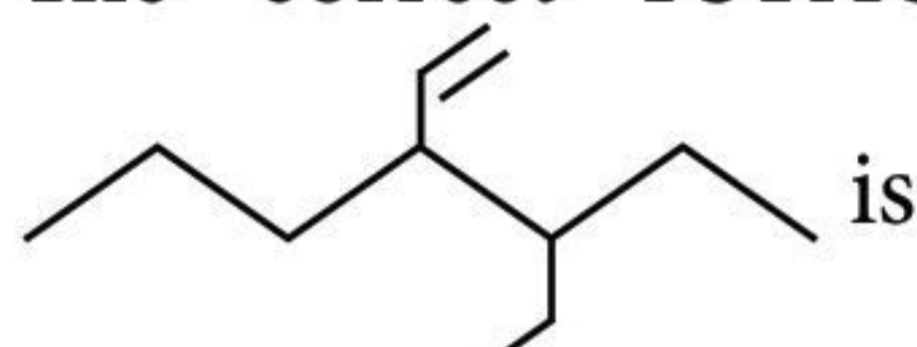
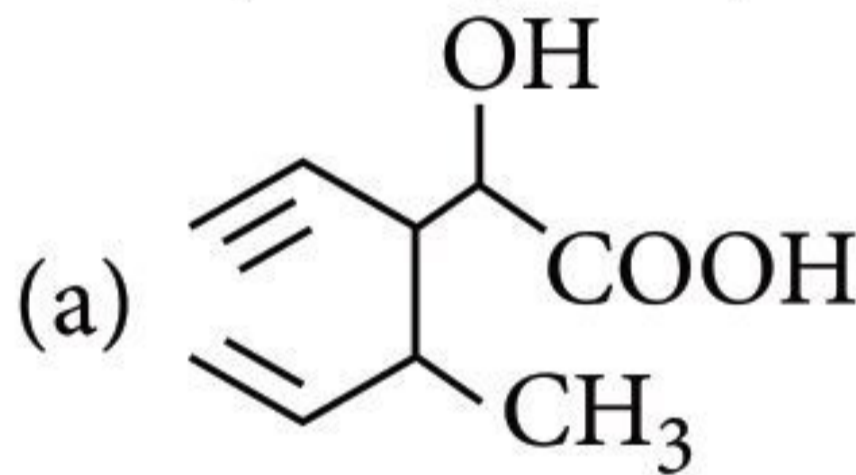
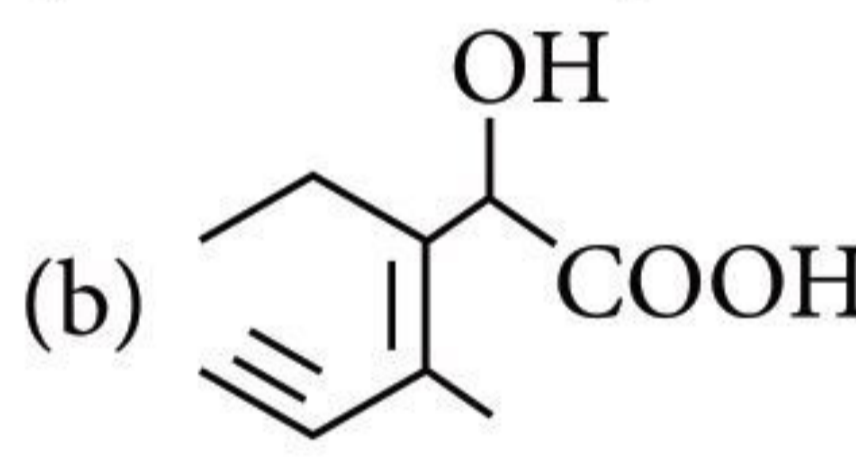
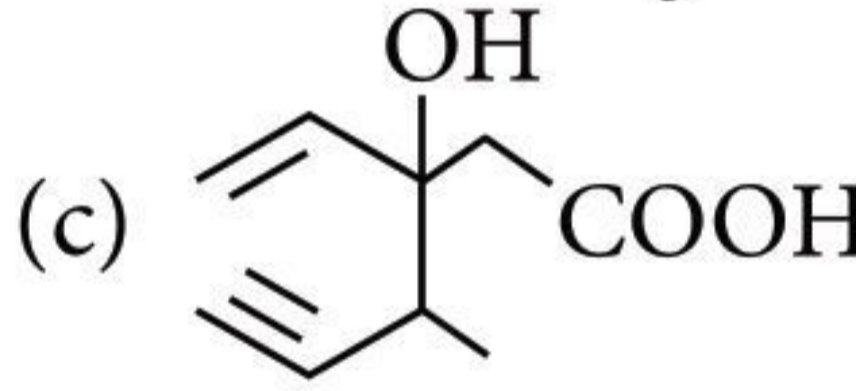
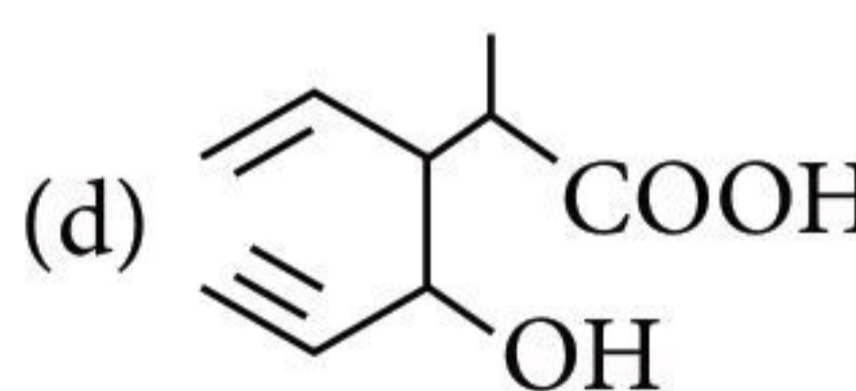
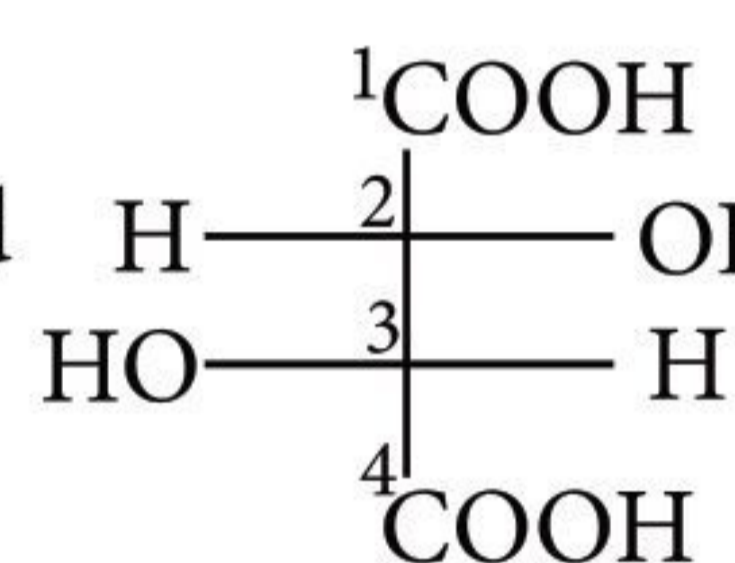
When we think of the most valuable material in the world, our minds tend to center on gold and while, gold is very expensive there are other materials that are significantly more expensive. The most expensive material in the world is Antimatter, which costs \$62.5 trillion a gram only. Antimatter is actually the perfect and exactly opposite counterpart to the matter as we see. It acts in essence as the nemesis of matter; and if somehow comes in contact with ordinary matter, leads to the total annihilation of both the matter and itself, in the process giving a lot of energy in the form of gamma-radiations, small subatomic particles known as neutrinos and sometimes other smaller matter-antimatter pairs.

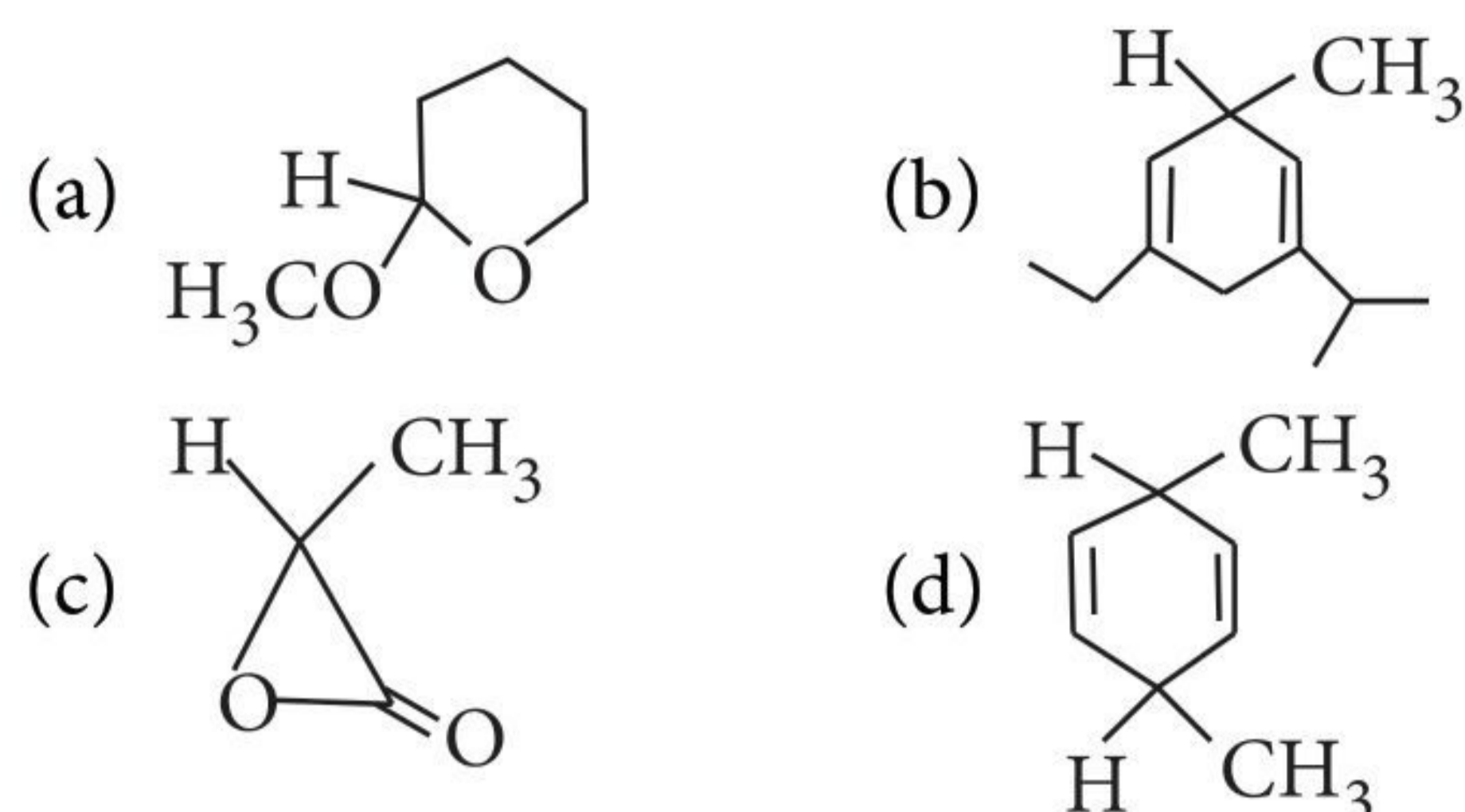




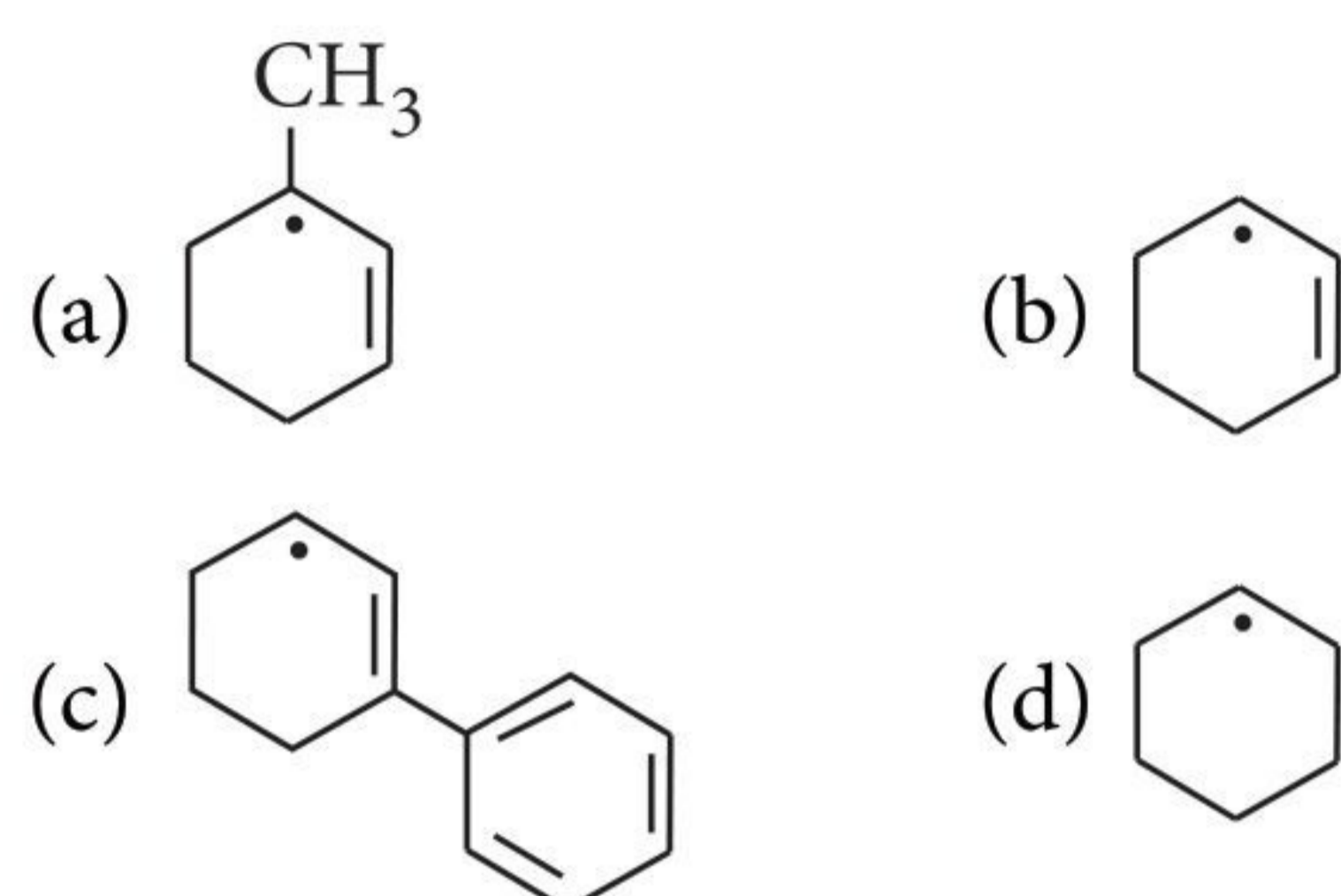
WRAP it up!

MCQs Type

- Consider the reaction,
 $RCHO + NH_2-NH_2 \rightarrow RCH=N-NH_2$
 What sort of reaction is this?
 (a) Nucleophilic addition – elimination reaction
 (b) Electrophilic addition – elimination reaction
 (c) Free radical addition – elimination reaction
 (d) Electrophilic substitution – elimination reaction
- The correct IUPAC name of the compound  is
 (a) 3-(1-ethylpropyl) hex-1-ene
 (b) 4-ethyl-3-propylhex-1-ene
 (c) 3-ethyl-4-ethenylheptane
 (d) 3-ethyl-4-propylhex-5-ene.
- Which of the following carbocations is least stable?
 (a) $C_6H_5\overset{+}{C}H_2$ (b) $p\text{-NO}_2-C_6H_4-\overset{+}{C}H_2$
 (c) $p\text{-CH}_3O-C_6H_4-\overset{+}{C}H_2$
 (d) $p\text{-Cl}-C_6H_4-\overset{+}{C}H_2$
- Structure of the compound whose IUPAC name is 3-ethyl-2-hydroxy-4-methylhex-3-en-5-ynoic acid is
 (a)  (b) 
 (c)  (d) 
- C—H bond energy is about 101 kcal/mol for methane, ethane and other alkanes but is only 77 kcal/mol for C—H bond of CH_3 in toluene. This is because
 (a) of inductive effect due to $-CH_3$ in toluene
 (b) of the presence of benzene ring in toluene
 (c) of resonance among the structures of benzyl radical in toluene
 (d) of aromaticity of toluene.
- Paper chromatography is an example of
 (a) adsorption chromatography
 (b) partition chromatography
 (c) thin layer chromatography
 (d) column chromatography. (NEET 2020)
- Among the following carbocations,
 (I) $Ph_2\overset{+}{C}CH_2Me$ (II) $PhCH_2CH_2\overset{+}{C}HPh$
 (III) $Ph_2CH\overset{+}{C}HMe$ (IV) $Ph_2C(Me)\overset{+}{C}H_2$
 the order of stability is
 (a) $IV > II > I > III$ (b) $I > II > III > IV$
 (c) $II > I > IV > III$ (d) $I > IV > III > II$
- In the compound  configurations of C_2 and C_3 respectively are
 (a) R, R (b) R, S (c) S, R (d) S, S
- Which of the following statements is incorrect?
 (a) Using Lassaigne's test, nitrogen and sulphur present in an organic compound can be tested.
 (b) Using Beilstein's test, the presence of halogens in a compound can be tested.
 (c) In Lassaigne's filtrate, the nitrogen in an organic compound is converted to NaCN.
 (d) In the estimation of carbon, an organic compound is heated with CaO in a combustion tube.
- Ethoxyethane and methoxypropane are
 (a) geometrical isomers
 (b) optical isomers
 (c) functional group isomers
 (d) metamers.
- Given below are two statements :
Statement I : A mixture of chloroform and aniline can be separated by simple distillation.
Statement II : When separating aniline from a mixture of aniline and water by steam distillation, aniline boils below its boiling point.
 In the light of the above statements, choose the most appropriate answer from the options given below.
 (a) Statement I is true but statement II is false.
 (b) Both statement I and statement II are true.
 (c) Both statement I and statement II are false.
 (d) Statement I is false but statement II is true. (JEE Main 2021)
- Identify the compound, which does not have a stereocenter?



13. Most stable free radical is



14. Generally it is more difficult to purify organic compounds than inorganic compounds because

- they are very unstable
- their melting point and boiling point are low
- organic compounds have low solubility
- physical constants of organic compounds and the impurities associated with them are very close to each other.

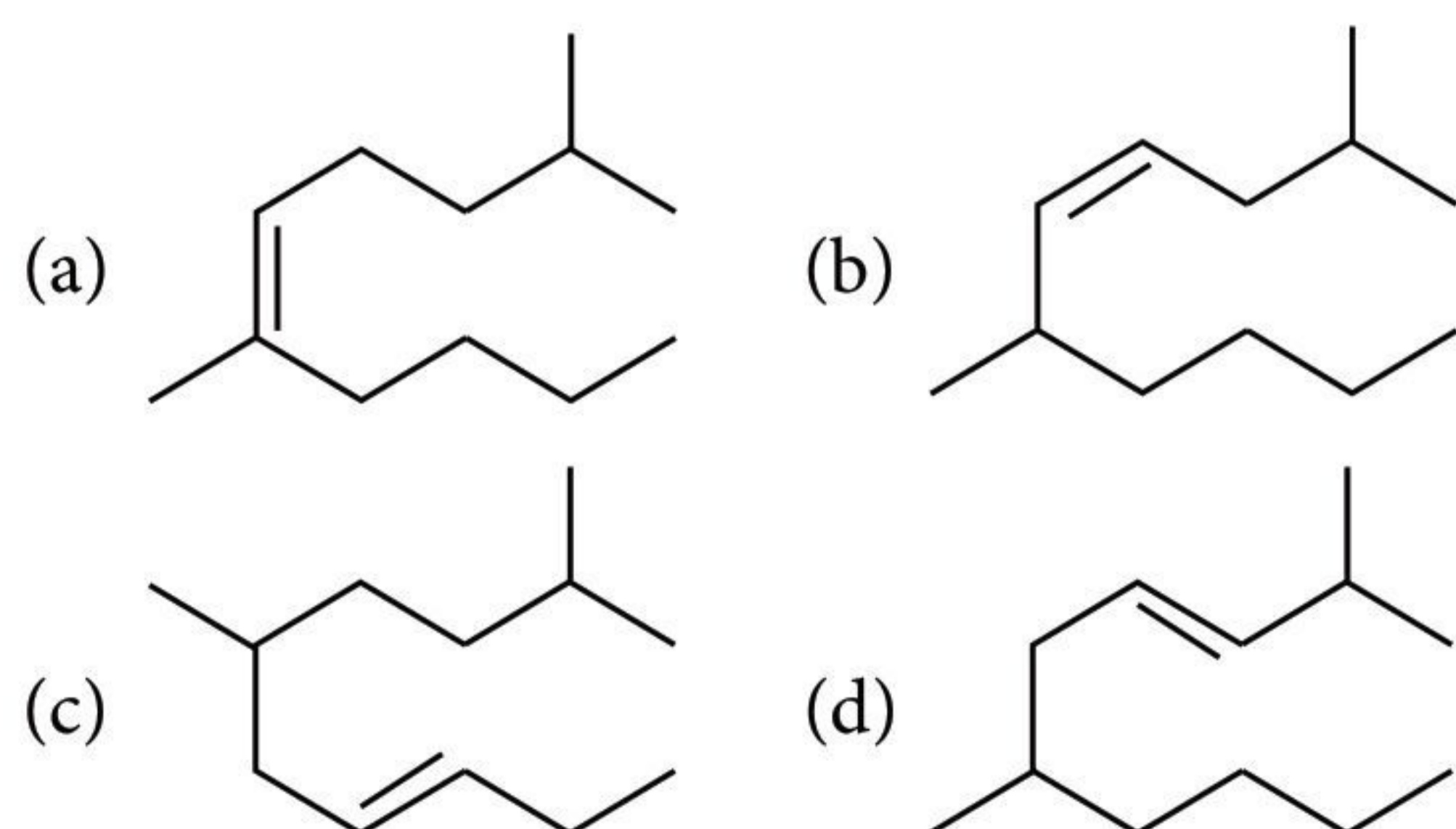
15. The simplest formula of a compound containing 50% of element X (at. wt. 10) and 50% of element Y (at. wt. 20) is

- (a) XY (b) XY₂ (c) X₂Y (d) X₂Y₃

16. The ammonia evolved from the treatment of 0.30 g of an organic compound for the estimation of nitrogen was passed in 100 mL of 0.1 M sulphuric acid. The excess of acid required 20 mL of 0.5 M NaOH solution for complete neutralisation. The organic compound is

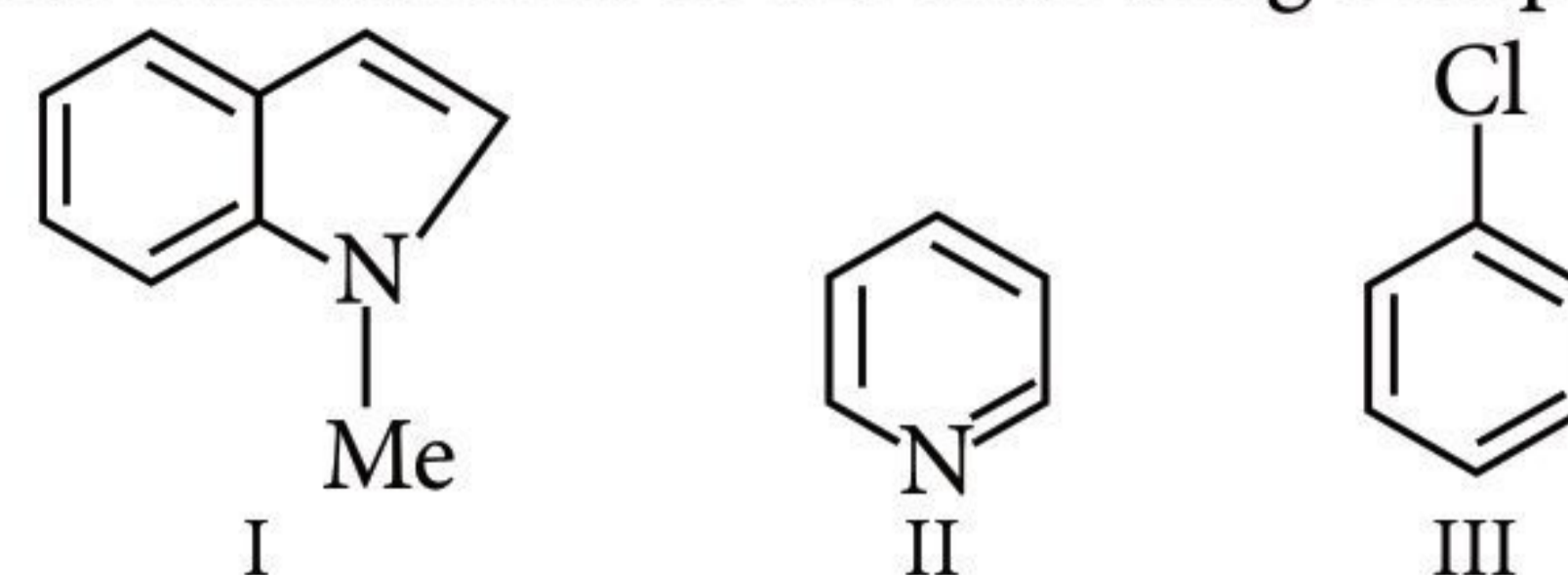
- thiourea
- benzamide
- urea
- acetamide.

17. The correct structure of 2, 6-dimethyl-dec-4-ene is



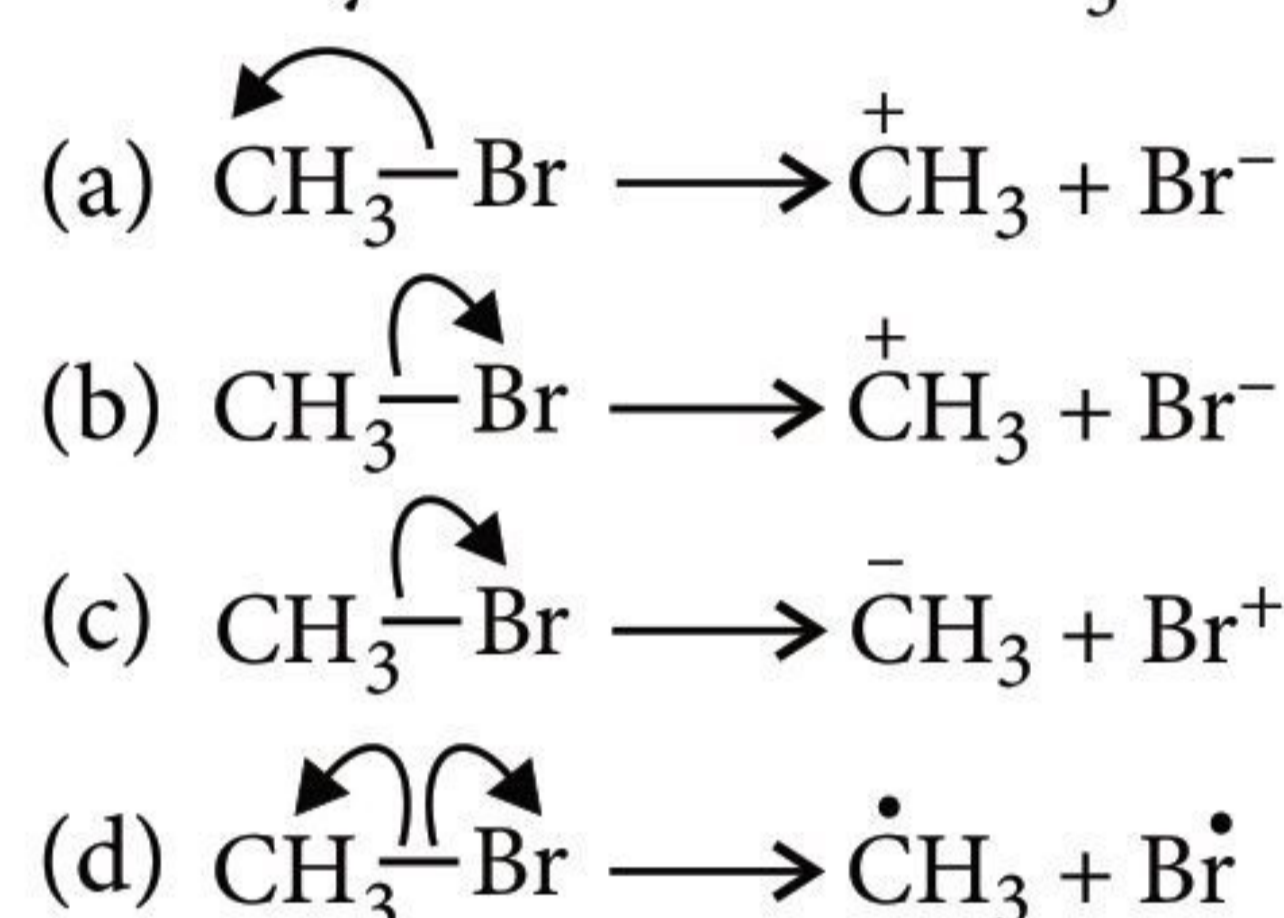
(NEET 2021)

18. The correct order for the rates of electrophilic aromatic substitution of the following compound is

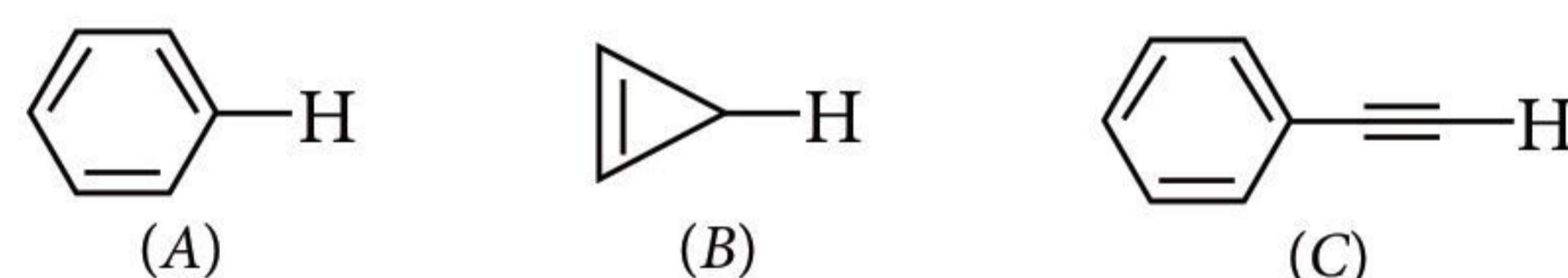


- I > II > III
- II > I > III
- III > II > I
- I > III > II

19. Covalent bond can undergo fission in two different ways. The correct representation involving a heterolytic fission of CH₃—Br is

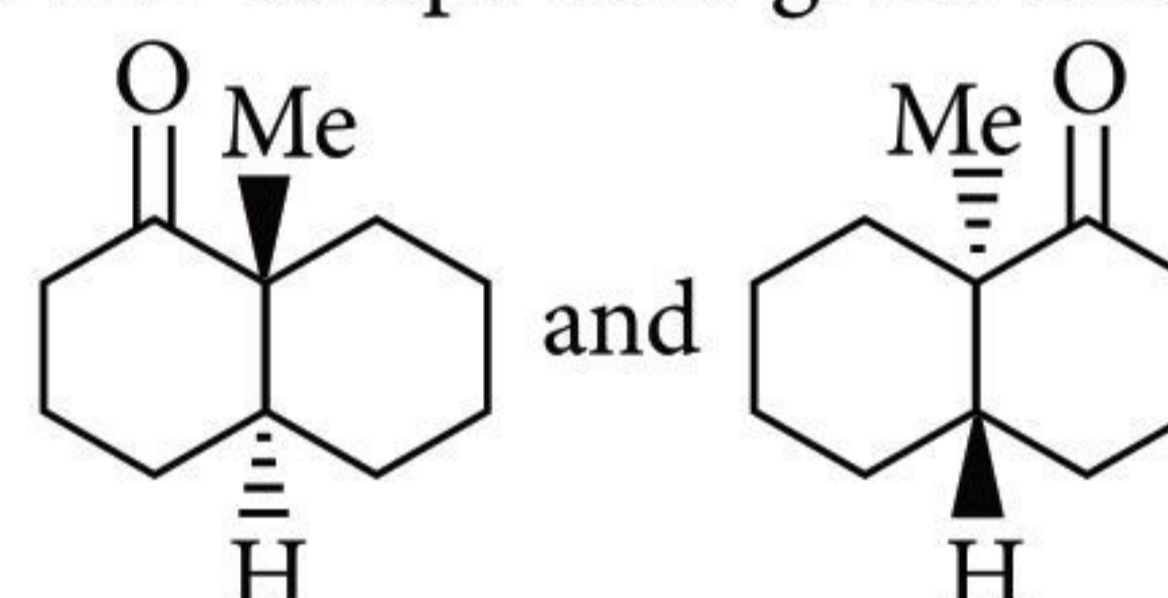


20. The correct order of bond dissociation energies for the indicated C — H bond in following compounds is



- C > B > A
- A > B > C
- A > C > B
- C > A > B

21. The two compounds given below are



- enantiomers
- identical
- diastereomers
- regioisomers.

22. Which of the following gives the correct order of decreasing electron-withdrawing effect?

- NO₂ > —CN > —F > —C₆H₅
- C₆H₅ > —F > —CN > —NO₂
- F > —CN > —C₆H₅ > —NO₂
- CN > —C₆H₅ > —NO₂ > —F

Quotable Quote

"An experiment is a question which science poses to Nature, and a measurement is the recording of Nature's answer."

Max Planck

23. Statement 1 : In butadiene, the C_2-C_3 single bond is slightly shorter than a normal carbon-carbon single bond.

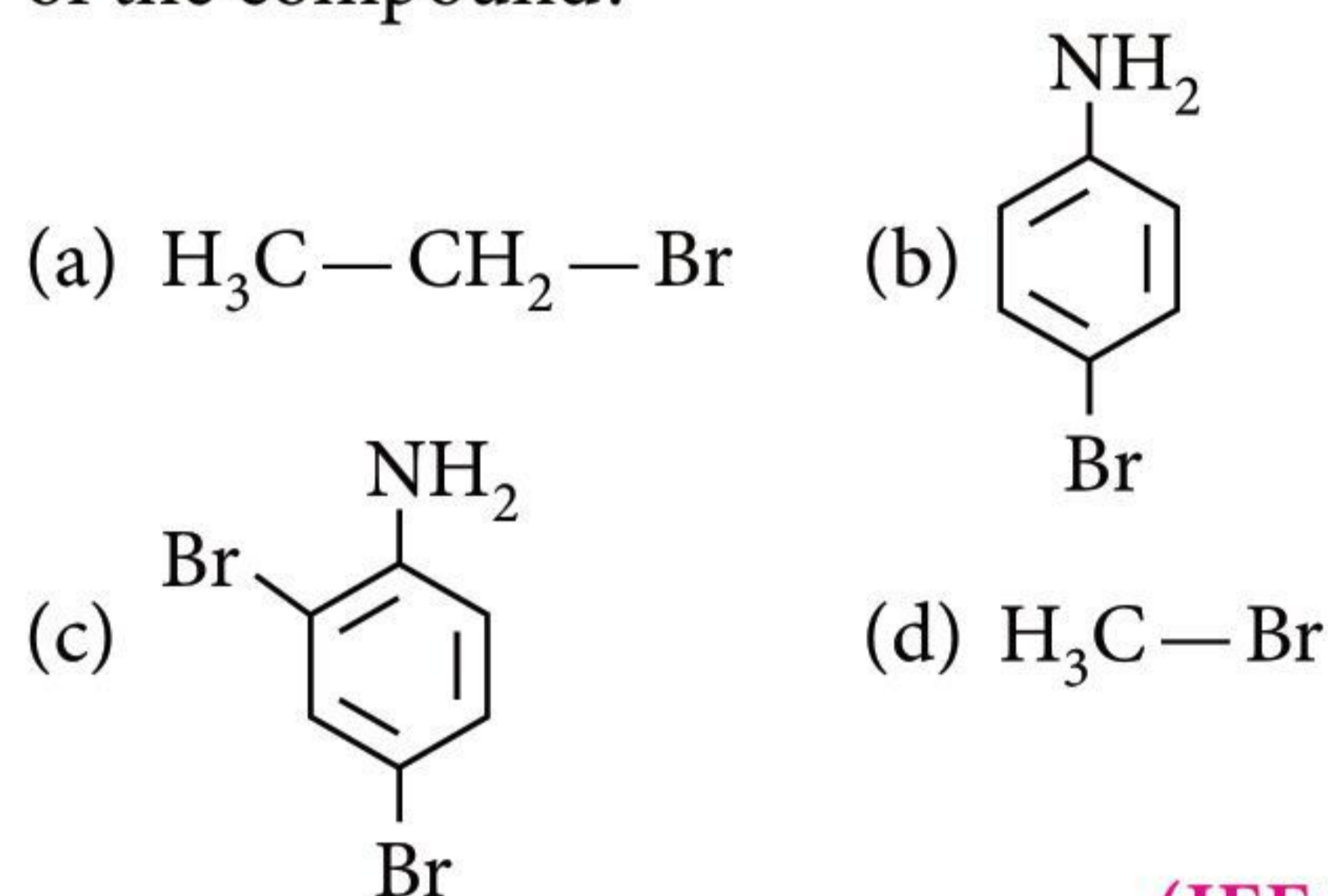
Statement 2 : The resonating structures of butadiene show that the C_2-C_3 bond has a partial double bond character.

- (a) Both statement 1 and statement 2 is true and statement 2 is the correct explanation for statement 1.
 (b) Both statement 1 and statement 2 is true but statement 2 is not the correct explanation for statement 1.
 (c) Statement 1 is true but statement 2 is false.
 (d) Statement 1 is false but statement 2 is true.

24. Steam distillation is particularly useful when at atmospheric pressure, the liquid

- (a) boils below 273 K and decomposes below its boiling point
 (b) boils above 273 K and decomposes at or below its boiling point
 (c) boils above 273 K and decomposes at or above its boiling point
 (d) boils at 273 K and does not decompose.

25. In Carius method of estimation of halogen, 0.172 g of an organic compound showed presence of 0.08 g of bromine. Which of these is the correct structure of the compound?

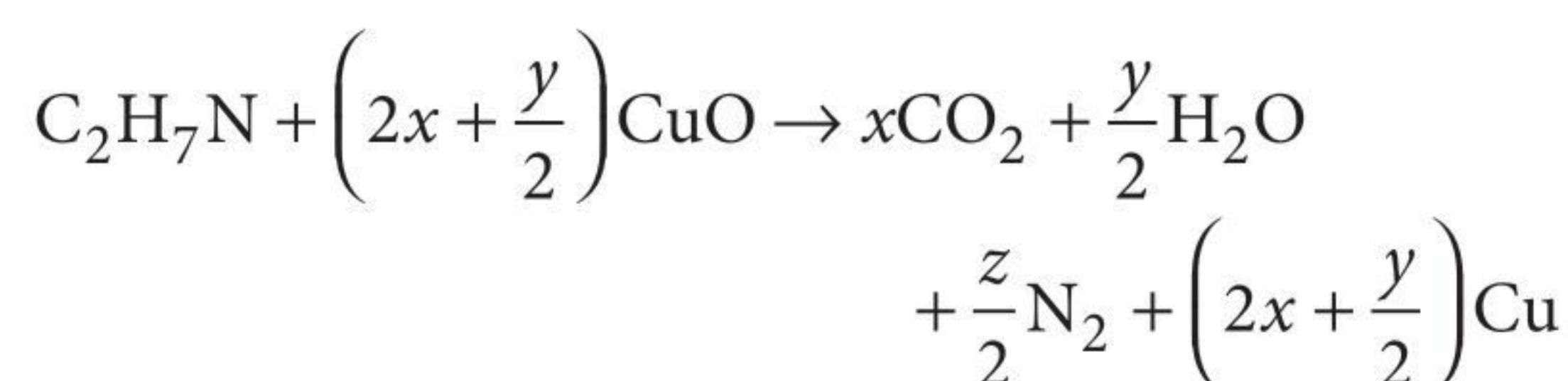


(JEE Main 2020)

NUMERICAL VALUE TYPE

26. If 0.2 g of an organic compound containing carbon, hydrogen and oxygen on combustion yielded 0.147 g CO_2 and 0.12 g water. What will be the percentage of oxygen in substance?

27. The transformation occurring in Duma's method is given below.



The value of y is _____. (Integer answer)

(JEE Main 2021)

28. The total number of cyclic isomers possible for a hydrocarbon with the molecular formula C_4H_6 is _____.

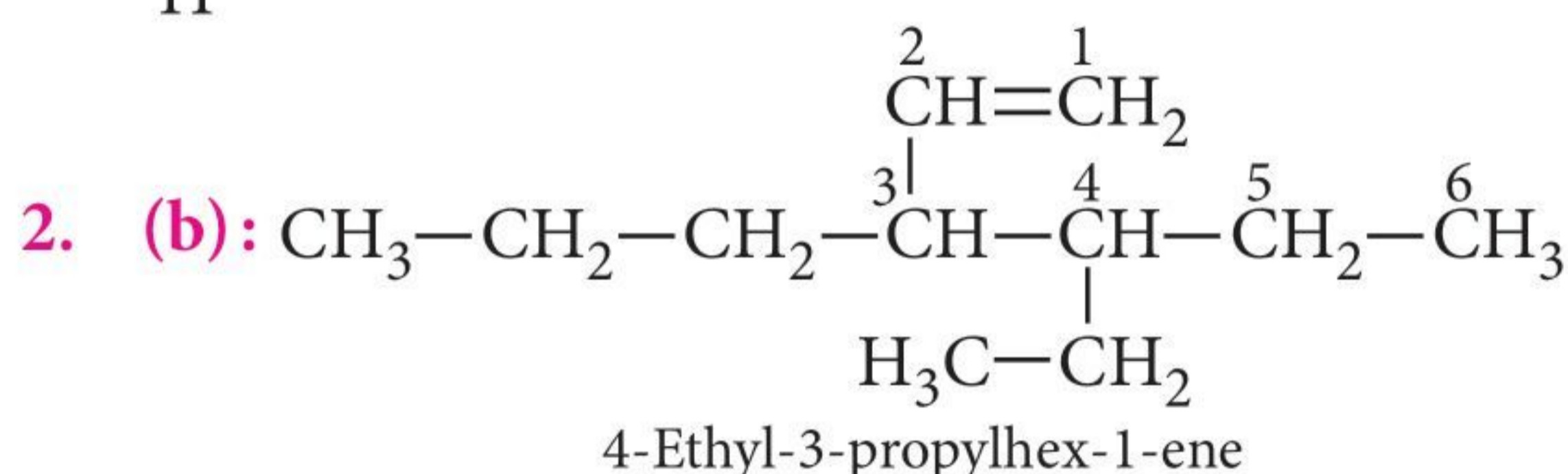
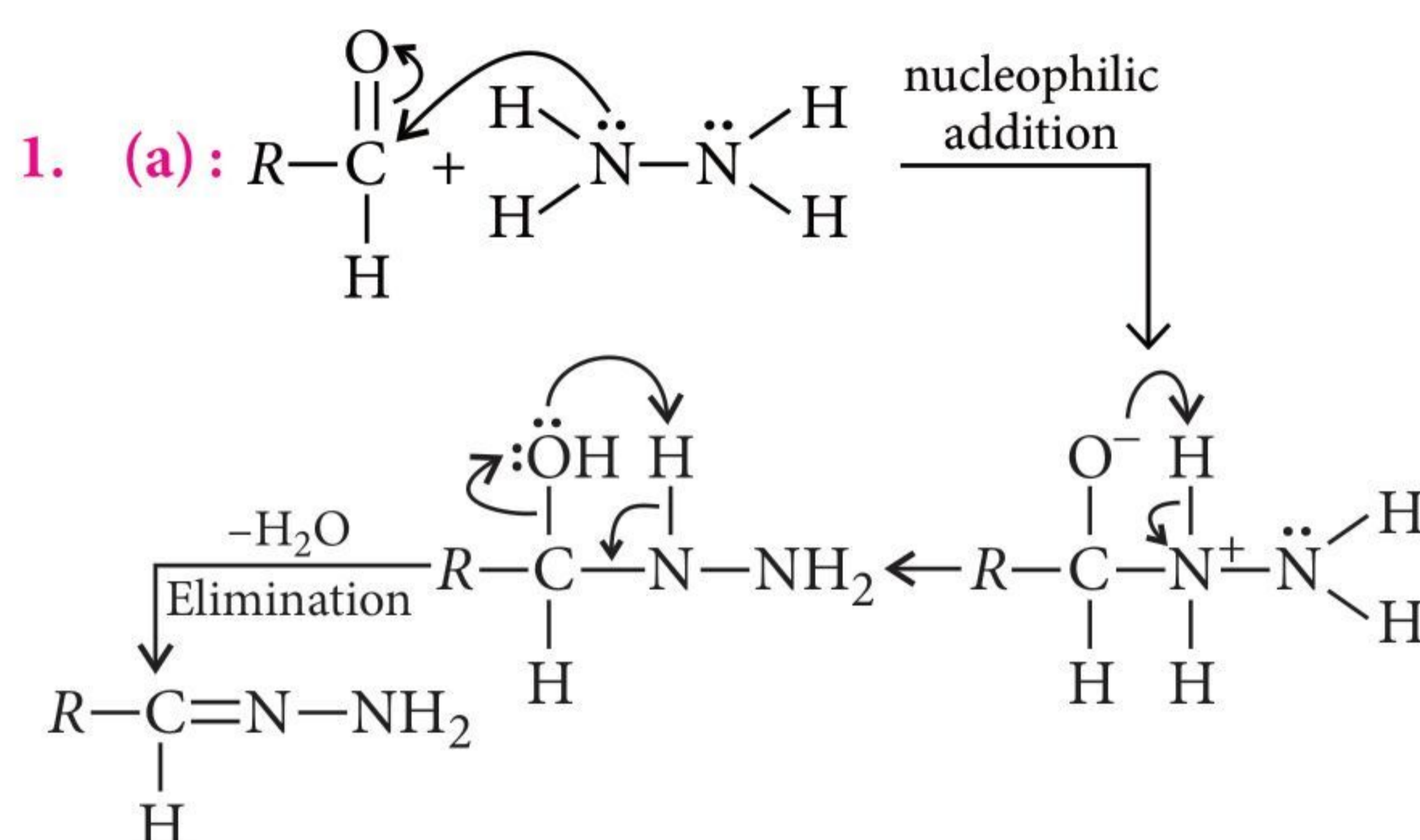
29. 0.75 g platinichloride of a monoacidic base on ignition gave 0.245 g platinum. The molecular weight of the base is _____.

30. In an estimation of bromine by Carius method, 1.6 g of an organic compound gave 1.88 g of $AgBr$. The mass percentage of bromine in the compound is _____.

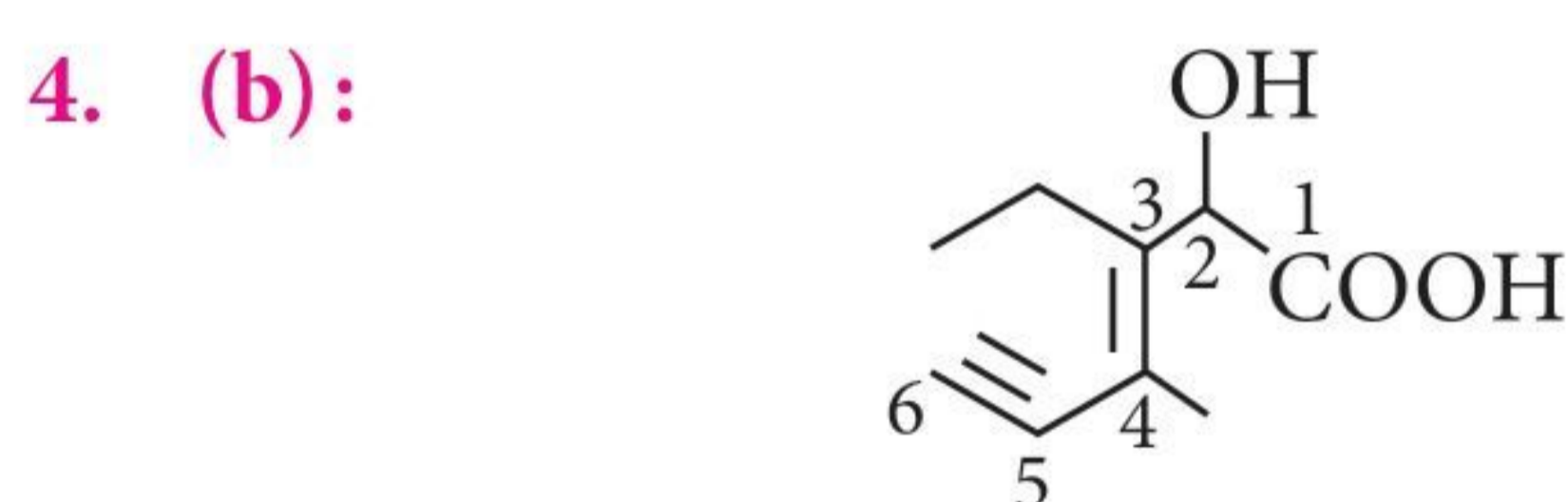
(Atomic mass, $Ag = 108$, $Br = 80 \text{ g mol}^{-1}$)

(JEE Main 2020)

SOLUTIONS



3. (b) : $p\text{-NO}_2-C_6H_4-\overset{+}{CH}_2$ is the least stable carbocation since electron withdrawing $-NO_2$ group destabilises the carbocation.



3-Ethyl-2-hydroxy-4-methylhex-3-en-5-ynoic acid

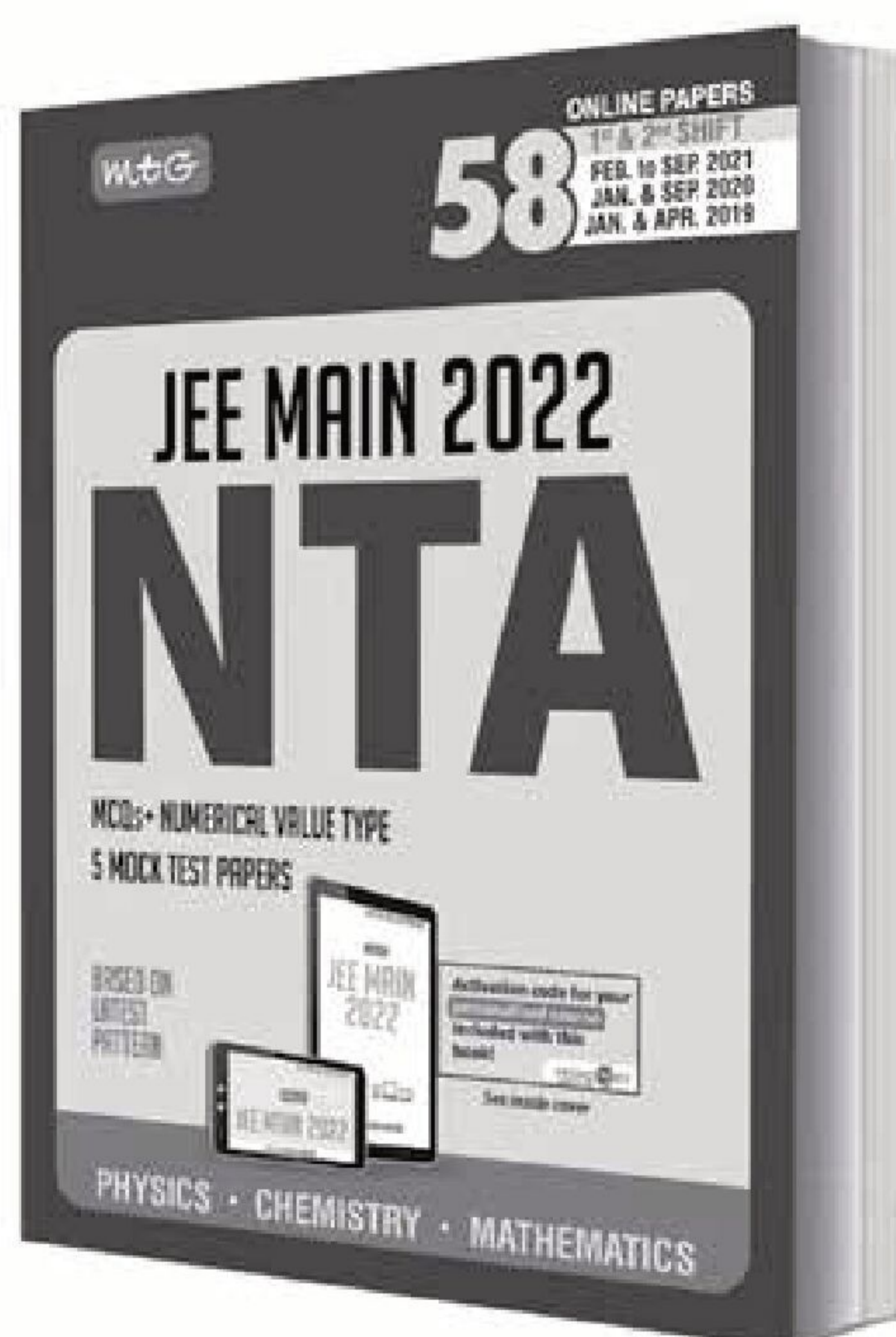
5. (c) : $C_{(alkyl)}-C_{(aryl)}$ bond in toluene has partial double bond character due to resonance.

\therefore C-H bond in toluene has less energy as compared to others.

6. (b) : Paper chromatography is a type of partition chromatography.

7. (b)

Reach the peak of readiness for JEE Main 2022

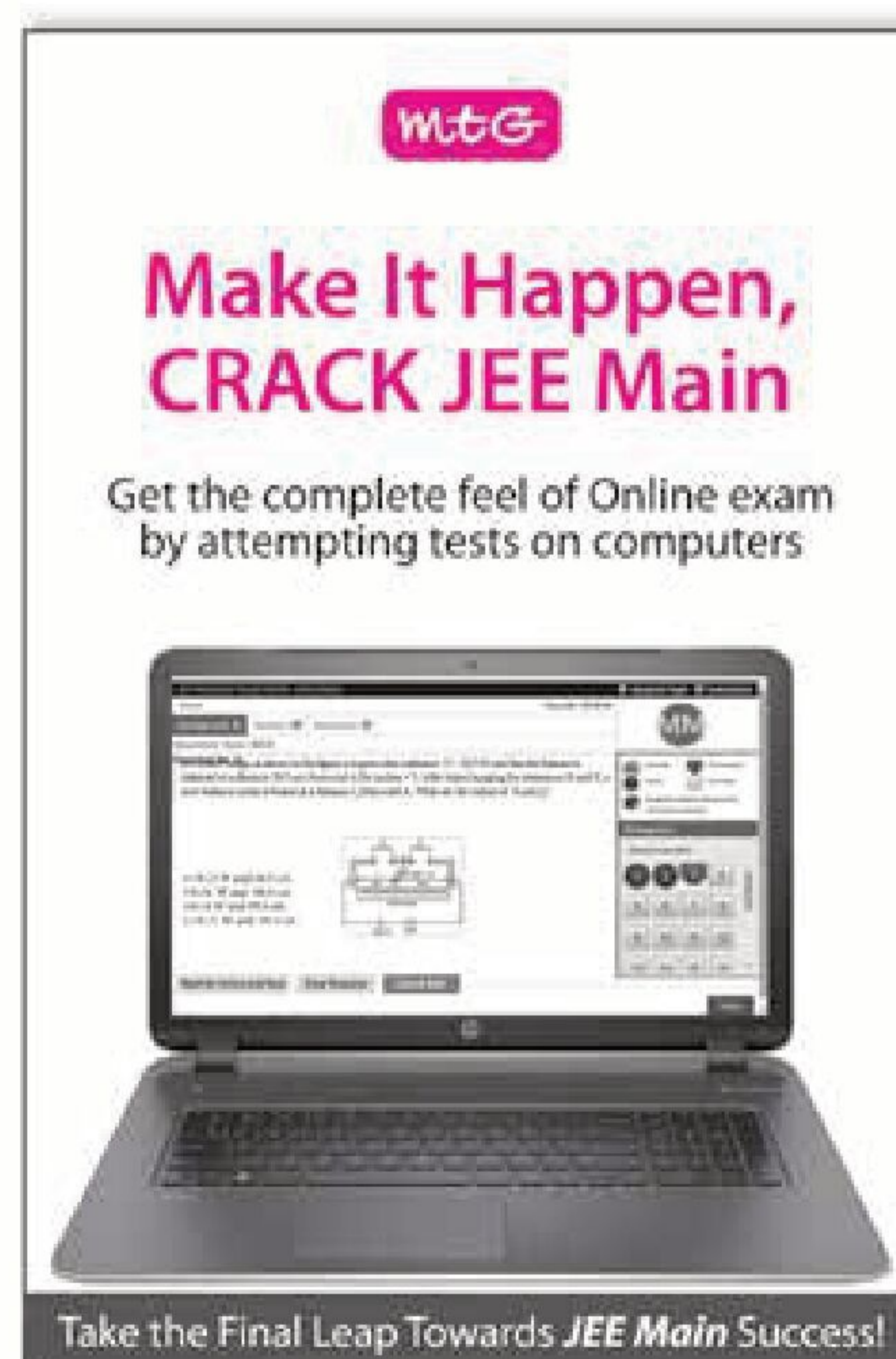


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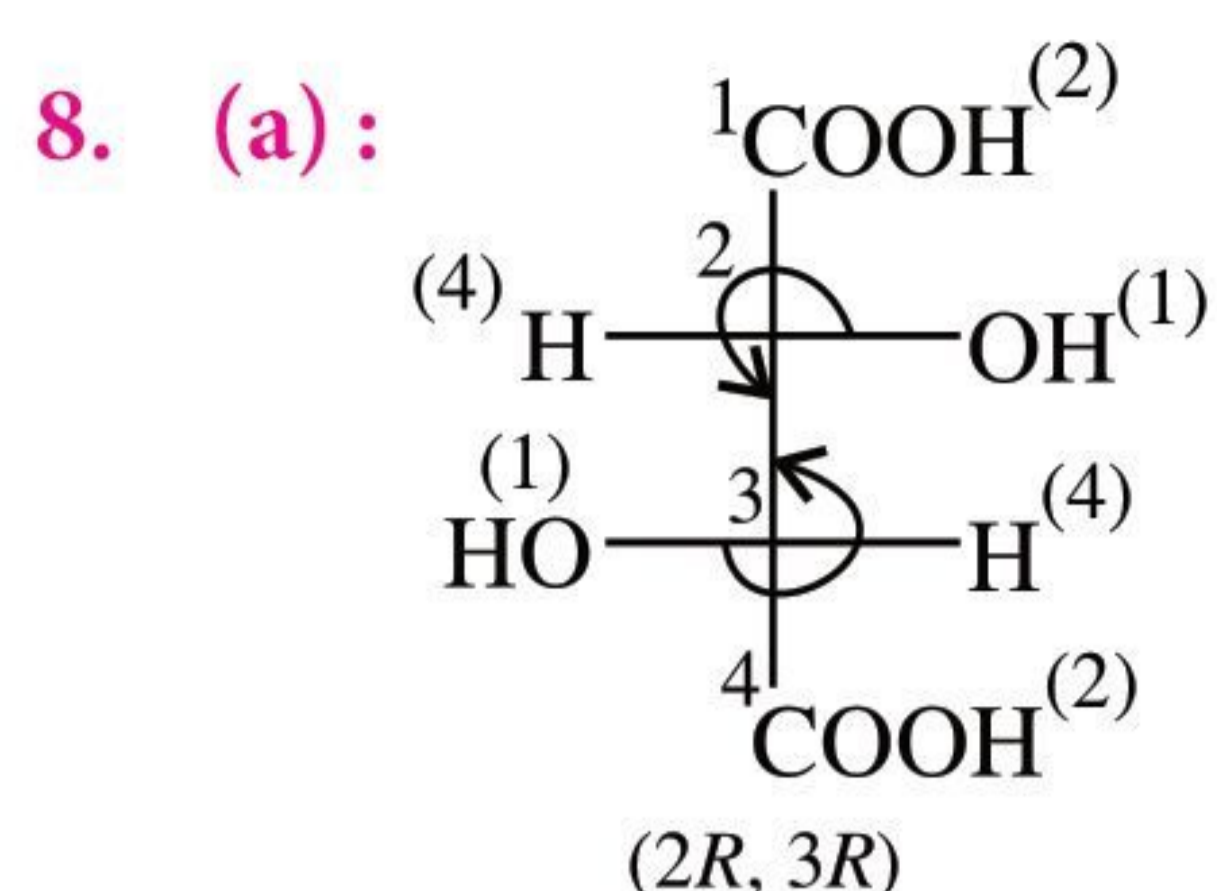
Highlights

- Fully Solved Authentic Papers
- 26 (Feb, March, July & Sept. 2021) + 16 (Jan. & Sept., 2020) + 16 (Jan. & Apr., 2019) Online Papers
- 4915 MCQs for Practice
- Chapterwise Tabular and Graphical Analysis Showing the Weightage of Chapters
- 5 MTPs as per the latest JEE Main pattern

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9. (d): In the estimation of carbon, organic compound is heated with excess of oxygen and CuO.

10. (d): Metamers differ in nature of alkyl groups on either side of the functional group.

11. (b): Chloroform (b.p. 334 K) and aniline (b.p. 457 K) have a big difference in their boiling point. Hence, the mixture can be separated by simple distillation. Statement-II is also true.

12. (d)

13. (c): The free radical in (c) is stabilised by resonance due to the presence of phenyl group as a substituent.

14. (d): In organic compounds, impurities associated with them have very close physical constants/properties.

15. (c):

Element	X	Y
Percentage	50	50
Atomic mass	10	20
Atomic ratio	50/10 = 5	50/20 = 2.5
Simplest ratio	5/2.5 = 2	2.5/2.5 = 1
Simple whole no. ratio	2	1

Hence, empirical formula is X_2Y .

16. (c): $0.1 \text{ M H}_2\text{SO}_4 = 0.2 \text{ N H}_2\text{SO}_4$
Applying, $N_1 V_1 (\text{H}_2\text{SO}_4) = N_2 V_2 (\text{NaOH})$
 $0.2 \times V_1 = 0.5 \times 20$

$$V_1 = \frac{0.5 \times 20}{0.2} = 50 \text{ mL}$$

\therefore Volume of H_2SO_4 used for $\text{NH}_3 = 100 - 50 = 50 \text{ mL}$

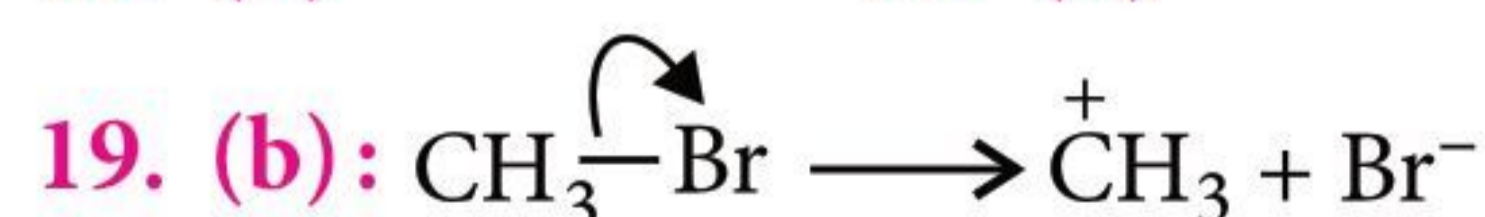
Percentage of N

$$= \frac{1.4 \times \text{Volume of acid used} \times \text{Normality of acid}}{\text{Weight of organic compound}}$$

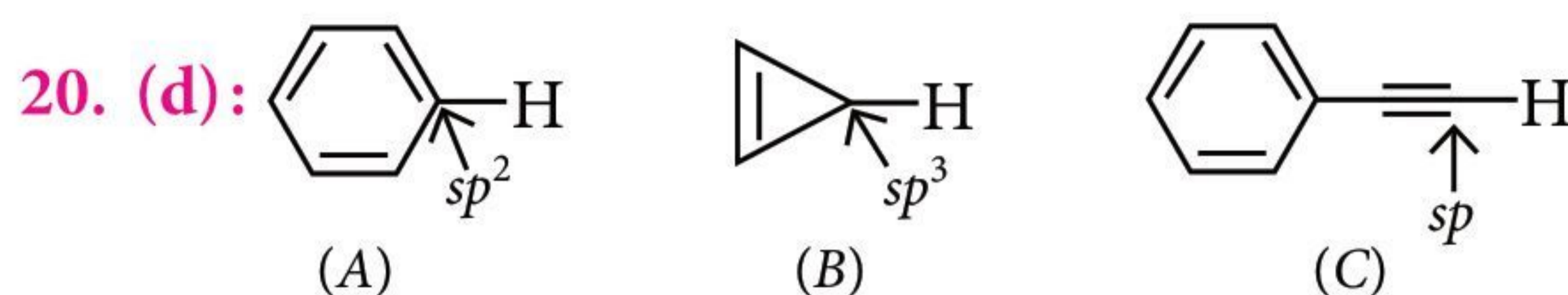
$$= \frac{1.4 \times 50 \times 0.2}{0.3} = 46.6\%$$

Percentage of N in urea (NH_2CONH_2) = 46%.

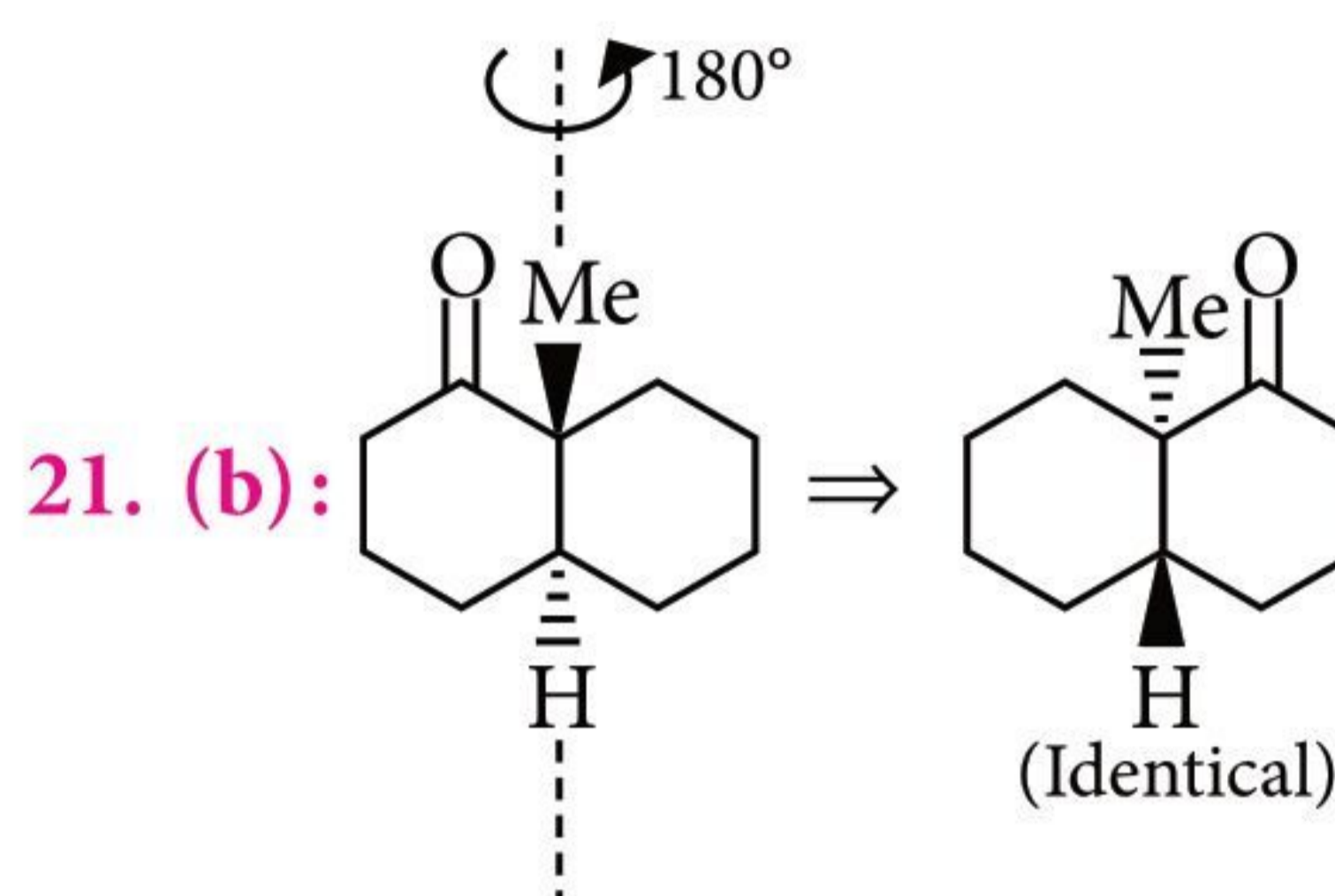
17. (b) 18. (d)



In heterolytic fission the electron pair goes with the more electronegative atom.



More is the s-character, stronger will be the bond, hence the bond dissociation energy follows the order: $C > A > B$



22. (a)

23. (a)

24. (b)

25. (b): Since, 0.172 g organic compound gives 0.08 g bromine. Hence, 172 g organic compound will give 80 g bromine, which matches with option (b).

26. (73.34): Percentage of C

$$= \frac{12}{44} \times \frac{\text{weight of CO}_2}{\text{weight of compound}} \times 100$$

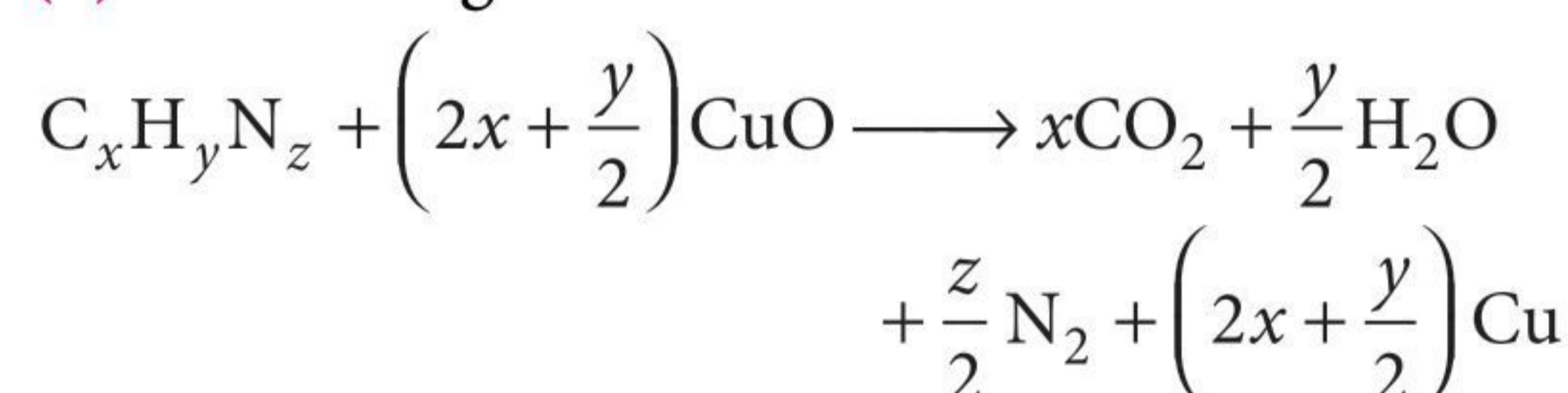
$$= \frac{12}{44} \times \frac{0.147}{0.2} \times 100 = 20\%$$

$$\text{Percentage of H} = \frac{2}{18} \times \frac{\text{weight of H}_2\text{O}}{\text{weight of compound}} \times 100$$

$$= \frac{2}{18} \times \frac{0.12}{0.2} \times 100 = 6.66\%$$

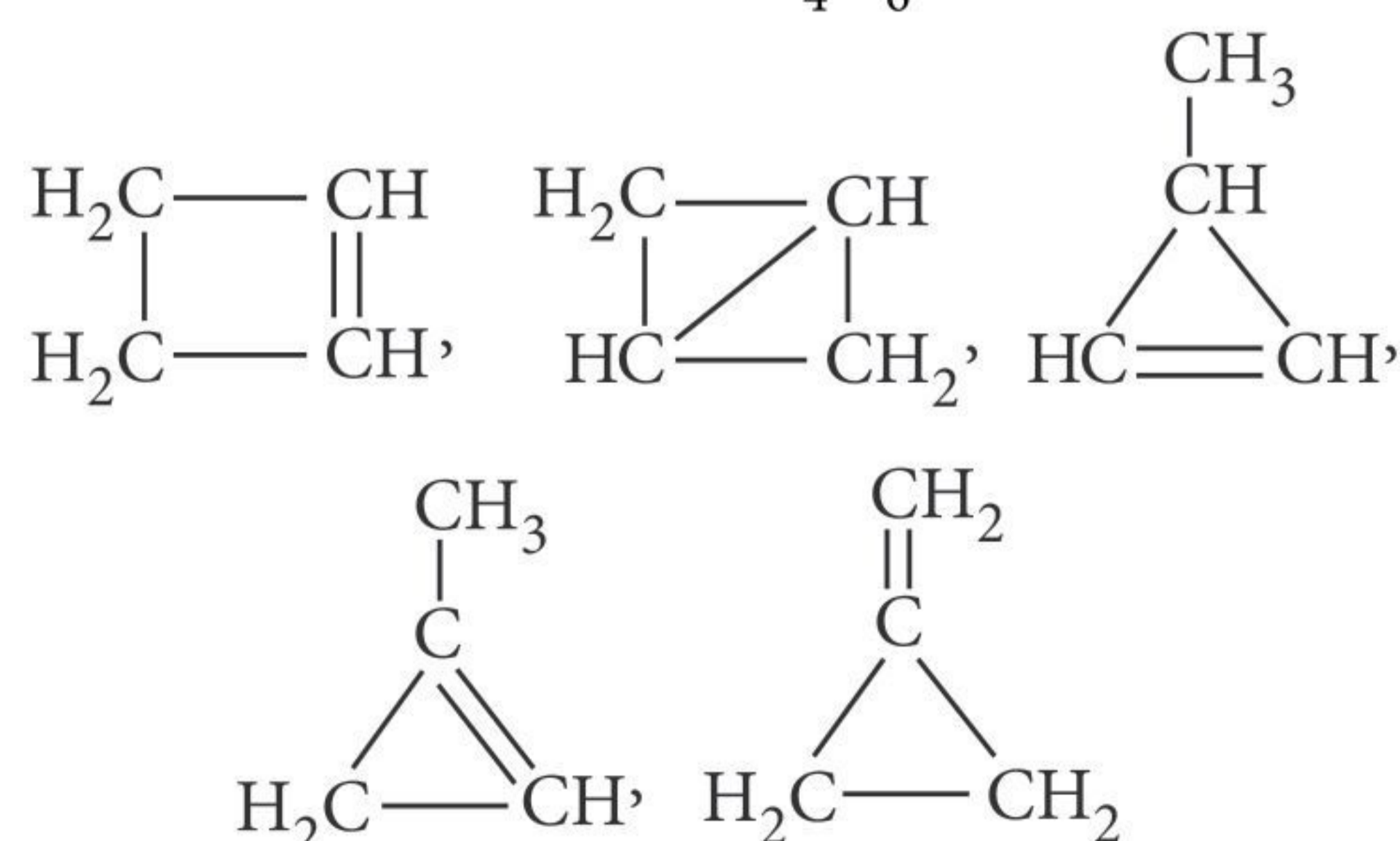
Percentage of O = $100 - (20 + 6.66) = 73.34\%$.

27. (7): According to Dumas method:



For $\text{C}_2\text{H}_7\text{N}$, $x = 2$, $y = 7$, $z = 1$

28. (5): The possible cyclic isomers of the compound with molecular formula C_4H_6 are:



29. (93.5) : Since acidity of base is 1 gram eq. of platinichloride = gram eq. of platinum

$$\frac{\text{Mass of platinichloride (B}_2\text{H}_2\text{PtCl}_6\text{)}}{\text{Molecular weight of platinichloride}} = \frac{\text{Mass of Pt}}{\text{Molecular mass of Pt}}$$

$$\frac{\text{Mass of platinichloride}}{2 \times \text{Mol Wt. of base} + 410} = \frac{\text{Mass of Pt}}{195}$$

$$\frac{\text{Mass of platinichloride}}{\text{Mass of platinum}} \times 195 - 410 = 2 \times \text{Mol. wt. of Base}$$

Molecular weight of base

$$= \left[\frac{\left(\frac{\text{Mass of platinichloride}}{\text{Mass of platinum}} \right) \times 195 - 410}{2} \right]$$

$$= \left[\frac{\left(\frac{0.75}{0.245} \times 195 \right) - 410}{2} \right] = 93.5$$

30. (50) : Percentage of Br

$$= \frac{\text{At. mass of Br} \times \text{Mass of AgBr formed} \times 100}{\text{Molecular mass of AgBr} \times \text{Mass of organic compound taken}}$$

$$= \frac{80 \times 1.88 \times 100}{188 \times 1.6} = 50\%$$



Scientist of the Month

Dorothy Mary Crowfoot Hodgkin

Early Life

- Dorothy Mary Crowfoot was born in Cairo, Egypt, the eldest of the four daughters of John Winter Crowfoot, then working for the country's Ministry of Education, and his wife Grace Mary.
- Her state school education did not include Latin, then required for entrance to Oxbridge. Her Leman School headmaster gave her personal tuition in the subject, enabling her to pass the University of Oxford entrance examination.
- On her 16th birthday her mother gave her a book on X-ray crystallography which helped her to decide her future. She was further encouraged by the chemist A.F. Joseph, a family friend who also worked in Sudan.



Dorothy Mary Crowfoot Hodgkin
(12 May 1910 - 29 July 1994)

Higher Education

- In 1928 at age 18 she entered Somerville College, Oxford, where she studied chemistry. She graduated in 1932 with a first-class honours degree, the third woman at this institution to achieve this distinction.
- In the autumn of that year, she began studying for a PhD at Newnham College, Cambridge, under the supervision of John Desmond Bernal. It was then that she became aware of the potential of X-ray crystallography to determine the structure of proteins. She was working with Bernal on the technique's first application to the analysis of a biological substance, pepsin. The pepsin experiment is largely credited to Hodgkin, however she always made it clear that it was Bernal who initially took the photographs and gave her additional key insights. Her PhD was awarded in 1937 for research on X-ray crystallography and the chemistry of sterols.

Career and Discoveries

- In 1933 Hodgkin was awarded a research fellowship by Somerville College, and in 1934, she moved back to Oxford. The college appointed her its first fellow and tutor in chemistry in 1936, a post which she held until 1977. She was a fellow of Wolfson College, Oxford from 1977 to 1983.

- Steroid structure :** Hodgkin was particularly noted for discovering three-dimensional biomolecular structures. In 1945, working with C. H. (Harry) Carlisle, she published the first such structure of a steroid, cholesteryl iodide.
- Penicillin structure :** In 1945, Hodgkin and her colleagues, including biochemist Barbara Low, solved the structure of penicillin, demonstrating, contrary to scientific opinion at the time, that it contains a β -lactam ring. The work was not published until 1949.
- Vitamin B₁₂ structure :** In 1948, Hodgkin first encountered vitamin B₁₂, and created new crystals. Vitamin B₁₂ had first been discovered at Merck earlier that year. It had a structure at the time that was almost completely unknown, and when Hodgkin discovered it contained cobalt, she realized the structure actualization could be determined by X-ray crystallography analysis.
- Insulin structure :** Insulin was one of Hodgkin's most extraordinary research projects. It began in 1934 when she was offered a small sample of crystalline insulin by Robert Robinson. The hormone captured her imagination because of the intricate and wide-ranging effect it has in the body. However, at this stage X-ray crystallography had not been developed far enough to cope with the complexity of the insulin molecule. She and others spent many years improving the technique.

Honours and Awards

- Hodgkin won the 1964 Nobel Prize in Chemistry, and is the only British woman scientist to have been awarded a Nobel Prize in any of the three sciences it recognises.
- In 1965 she was appointed to the Order of Merit.
- She was the first woman to receive the prestigious Copley Medal.
- She was elected a Fellow of the Royal Society (FRS) in 1947 and EMBO Membership in 1970. Hodgkin was Chancellor of the University of Bristol from 1970 to 1988.
- In 1966, she was awarded the Iota Sigma Pi National Honorary Member for her significant contribution.
- In 1982 she received the Lomonosov Medal of the Soviet Academy of Sciences.
- In 1987 she accepted the Lenin Peace Prize from the government of Mikhail Gorbachev.
- The communist government of Bulgaria awarded her its Dimitrov Prize.
- In 1983, Hodgkin received the Austrian Decoration for Science and Art.



CBSE

Term-II

warm-up!

CLASS-XI

Series-1

States of Matter | The s-block Elements | Hydrocarbons

Time Allowed : 2 hours
Maximum Marks : 35

General Instructions : Read the following instructions carefully.

- (a) There are 16 questions in this question paper. All questions are compulsory.
- (b) Section A : Q. No. 1 to 8 are objective type questions. Q. No. 1 is passage based question carrying 4 marks while Q. No. 2 to 8 carry 1 mark each.
- (c) Section B : Q. No. 9 to 12 are short answer questions and carry 2 marks each.
- (d) Section C : Q. No. 13 and 14 are short answer questions and carry 3 marks each.
- (e) Section D : Q. No. 15 and 16 are long answer questions carrying 5 marks each.
- (f) There is no overall choice. However, internal choices have been provided.
- (g) Use of calculators and log tables is not permitted.

SECTION - A (OBJECTIVE TYPE)

1. Read the passage given below and answer the following questions :

Combining both Boyle's law and Charles' law, we get
 $V \propto \frac{1}{p} \times T$, When both p and T vary.

$$V = k_m \frac{T}{p} \Rightarrow p \frac{V}{T} = k_m$$

Where k_m is a proportionality constant that changes with the mass of a gas.

Let us suppose that for a given mass of gas, the initial pressure, volume and temperature are p_1 , V_1 and T_1 respectively and that their values change to p_2 , V_2 and T_2 later. Then

$$\frac{p_1 V_1}{T_1} = k_m \text{ and } \frac{p_2 V_2}{T_2} = k_m ; \quad \frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

The above equation is called the combined gas law equation, applicable to a fixed mass of a gas.

The following questions are multiple choice questions. Choose the most appropriate answer :

- (i) The volume of 0.0168 mol of O_2 obtained by decomposition of $KClO_3$ and collected by displacement of water is 428 mL at pressure 754 mmHg at $25^\circ C$. The pressure of water vapour at $25^\circ C$ is
 - (a) 18.5 mm Hg
 - (b) 20.6 mm Hg
 - (c) 22.3 mm Hg
 - (d) 24.6 mm Hg
- (ii) The pressure of a fixed amount of an ideal gas is 0.75 N m^{-2} . What will be the pressure after the volume of the gas is tripled and the absolute temperature is doubled?
 - (a) 0.75 N m^{-2}
 - (b) 0.25 N m^{-2}
 - (c) 0.50 N m^{-2}
 - (d) 1.00 N m^{-2}

**This is for practice purpose. CBSE has yet not released the official sample paper.
So, the pattern is suggestive only. For latest information visit www.cbse.gov.in.*

- (iii) A jar contains a gas and a few drops of water at T K. The pressure in the jar is 830 mm of Hg. The temperature of the jar is reduced by 1%. The vapour pressure of water at two temperatures are 30 and 25 mm of Hg respectively. The new pressure in the jar is
 (a) 717 mm Hg (b) 1000 mm Hg
 (c) 817 mm Hg (d) 60 mm Hg
- (iv) The temperature of a gas in a closed container is 27°C . If the temperature is raised to 327°C the pressure exerted is
 (a) reduced to half (b) doubled
 (c) reduced to one-third (d) cannot be calculated from the given information.

OR

A gas at 10°C occupies a volume of 283 mL. If it is heated to 20°C keeping the pressure constant the new volume will be

- (a) 289 mL (b) 283 mL
 (c) 293 mL (d) 566 mL

Following questions (Q. No. 2-6) are multiple choice questions carrying 1 mark each :

2. According to Boyle's law, the product of the pressure and volume of a fixed mass of gas at a fixed temperature is a constant, say k . The value of k
 (a) is an absolute constant
 (b) depends upon the mass of the gas
 (c) depends upon the temperature
 (d) depends upon both mass and temperature.
3. An element reacts with hydrogen to form a compound A, which on treatment of water liberates hydrogen gas. The element can be
 (a) chlorine (b) selenium
 (c) calcium (d) nitrogen.

OR

An alloy of Na + K is

- (a) liquid at room temperature
 (b) used in specially designed thermometers
 (c) both (a) and (b) (d) none of these.
4. Upon reacting with chlorine at 873 K, propene gives
 (a) 1, 2-dichloropropane (b) 1-chloropropane
 (c) 3-chloropropene (d) 2-chloropropene
5. $\text{RCH}_2\text{CCl}_2\text{R} \xrightarrow{\text{Reagent}} \text{RC}\equiv\text{CR}$
 The reagent used is
 (a) Na (b) $\text{HCl}/\text{H}_2\text{O}$
 (c) KOH in $\text{C}_2\text{H}_5\text{OH}$ (d) $\text{Cu}/\text{Alcohol}$

OR

2-Butyne is allowed to react with hydrogen in the presence of the Lindlar catalyst. The major product formed is

- (a) *cis*-2-butene (b) *trans*-2-butene
 (c) butane (d) 1, 3-butadiene.

6. The chloride that can be extracted with ether is
 (a) NaCl (b) LiCl
 (c) BaCl_2 (d) CaCl_2

In the following questions (Q. No. 7 and 8), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
 (b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
 (c) Assertion is correct statement but reason is wrong statement.
 (d) Assertion is wrong statement but reason is correct statement.

7. **Assertion :** K, Rb and Cs (group I elements) can also form superoxides.

Reason : The ionic radii of K, Rb and Cs show the trend, $\text{Cs}^+ < \text{Rb}^+ < \text{K}^+$.

OR

Assertion : Li_2CO_3 decomposes easily on heating to form Li_2O and CO_2 .

Reason : Li^+ is very small in size and applies very high polarising power on CO_3^{2-} ion leading to the decomposition of Li_2CO_3 .

8. **Assertion :** Real gases deviate from the ideal behavior at high temperatures and low pressures.

Reason : The volume of the molecules of a gas is negligible in comparison with the total volume of the gas at low pressure and high temperature.

SECTION - B

The following questions Q. No. 9-12 are short answer type and carry 2 marks each.

9. The values of van der Waals' constant a for hydrogen and ammonia are $0.024 \text{ atm L}^2 \text{ mol}^{-2}$ and $4.17 \text{ atm L}^2 \text{ mol}^{-2}$ respectively. What conclusion do you draw from this data?

OR

The drain cleaner, Drainex contains small bits of aluminium which react with caustic soda to produce dihydrogen. What volume of dihydrogen at 20°C and one bar will be released when 0.15 g of aluminium reacts?

10. Why does solubility of sulphates in water of group-2 decrease as we move down the group?
11. Among LiI or KI, which one is more soluble in ethanol and why?
12. An alkane has the molecular mass equal to 72 g/mol. Give the possible structural isomers along with their IUPAC names.

OR

- (i) What would be the product(s) obtained via oxymercuration ($\text{HgSO}_4 + \text{H}_2\text{SO}_4$) of 1-butyne
- (ii) Acetylene is acidic but it does not react with NaOH or KOH. Give reason.

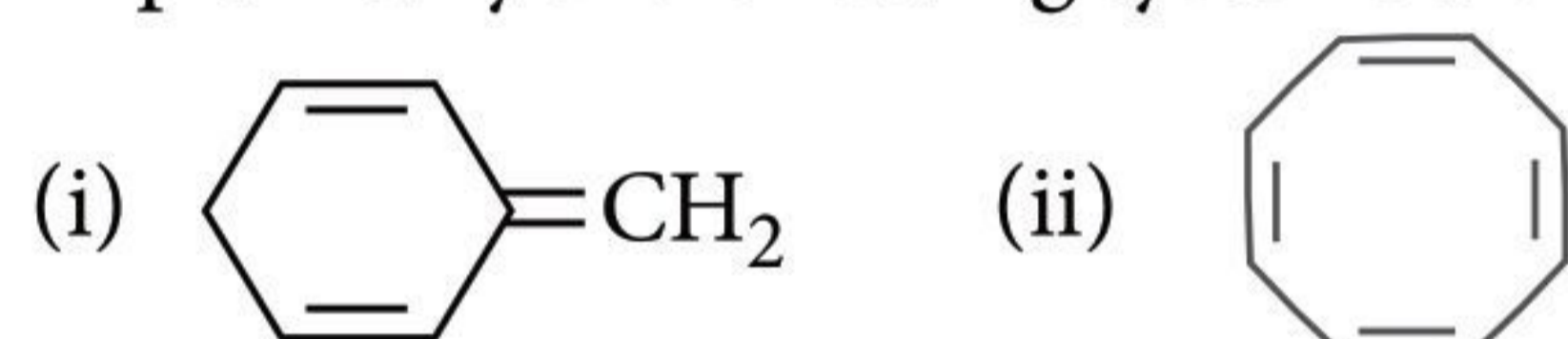
SECTION - C

Q. No. 13 and 14 are short answer type II carrying 3 marks each.

13. How would you distinguish between
- Magnesium and calcium
 - Na_2CO_3 and NaHCO_3
 - KNO_3 and LiNO_3
14. Compound (A), C_6H_{12} decolourises bromine dissolved in carbon tetrachloride. Reaction of (A) with alkaline KMnO_4 yields only (B) which is potassium salt of an acid. Write the structures and IUPAC names of the compounds (A) and (B).

OR

Explain why the following systems are not aromatic?



SECTION - D

Q. No. 15 and 16 are long answer type carrying 5 marks each.

15. (i) A gaseous mixture in a cylinder comprises 70% N_2 , 25% O_2 and 5% CO_2 by volume. If the pressure of the gaseous mixture is 760 mmHg, calculate the partial pressure of each gas.
- (ii) Helium gas contained in a vessel at 27°C and 1 atm effuses through a crack in the vessel. If 16 mL of helium effuses in 30 s, what volume of SO_2 at 327°C and 1 atm will effuse out of the same vessel in the same time?

OR

- (i) A liquefied petroleum gas (LPG) cylinder weighs 14.8 kg when empty. When full it weighs 29.0 kg and shows a pressure of 2.5 atm. In the course of use at 27°C , the mass of the full cylinder is reduced to 23.2 kg. Find out the

volume of the gas in cubic metres used up at the normal usage conditions and the final pressure inside the cylinder. Assume LPG to be *n*-butane with normal boiling point of 0°C .

- (ii) A certain volume of dry air at NTP is expanded reversibly to four times its volume isothermally. Calculate the final pressure.
16. (i) How will you prepare *cis*-pent-2-ene and *trans*-pent-2-ene by starting with ethyne?
- (ii) Explain the following :
- tert*-Butylbenzene does not give benzoic acid on oxidation with acidic KMnO_4 .
 - $\text{CH}_2=\text{CH}^-$ is more basic than $\text{HC}\equiv\text{C}^-$.

OR

- (i) Predict the major product in the following reaction :
- $$\text{C}_6\text{H}_6 + (\text{CH}_3)_2\text{CHCH}_2\text{OH} \xrightarrow{\text{H}_2\text{SO}_4}$$
- (ii) How will you convert benzene into
- p*-nitrobromobenzene
 - m*-nitrochlorobenzene?
- (iii) Why does benzene undergo electrophilic substitution reactions easily and nucleophilic substitution reactions with difficulty?

SOLUTIONS

1. (i) (d) : Volume of 0.0168 mol of O_2 at STP
- $$= 0.0168 \times 22400 \text{ mL} = 376.3 \text{ mL}$$
- $$V_1 = 376.3 \text{ mL}, p_1 = 760 \text{ mmHg}, T_1 = 273 \text{ K}$$
- $$V_2 = 428 \text{ mL}, p_2 = ?, T_2 = 298 \text{ K}$$
- $$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2} \Rightarrow \frac{760 \times 376.3}{273} = \frac{p_2 \times 428}{298}$$
- $$\Rightarrow p_2 = 729.4 \text{ mm Hg}$$
- $$\therefore \text{Pressure of water vapour} = 754 - 729.4 = 24.6 \text{ mm Hg}$$

(ii) (c)

(iii) (c) : The pressure of gas at T K = $830 - 30$

$$= 800 \text{ mm Hg}$$

After the temperature of the jar is reduced by 1%, the

temperature, T' becomes, $T' = T - \frac{1}{100}T = \frac{99}{100}T$

Let the new pressure be p' .

$$\text{Thus, } \frac{800}{T} = \frac{p'}{T'}; \frac{800}{T} = \frac{p'}{\frac{99}{100}T}$$

$$p' = \frac{800}{T} \times \frac{99T}{100} = 792 \text{ mm Hg}$$

Thus, total pressure in the jar at $T' = 792 + 25$
 $= 817 \text{ mm Hg}$

(iv) (b) : Given, $T_1 = 27^\circ\text{C} = 300 \text{ K}$

$T_2 = 327^\circ\text{C} = 600 \text{ K}$

Closed container shows that volume is constant.

$$\frac{p_1}{T_1} = \frac{p_2}{T_2} ; \frac{p_1}{300} = \frac{p_2}{600} \therefore p_2 = \frac{600}{300} p_1 = 2p_1$$

OR

(c) : $V_1 = 283 \text{ mL}$, $T_1 = 273 + 10 = 283 \text{ K}$

$V_2 = ?$ $T_2 = 273 + 20 = 293 \text{ K}$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \text{ (at constant } p\text{)}$$

$$V_2 = \frac{V_1}{T_1} \times T_2 = \frac{283 \times 293}{283} = 293 \text{ mL}$$

2. (d)

3. (c) : $\text{Ca} + \text{H}_2 \longrightarrow \text{CaH}_2 \xrightarrow{2\text{H}_2\text{O}} \text{Ca(OH)}_2 + 2\text{H}_2$
 Thus the element is calcium.

OR

(c) : A characteristic feature of Na-K alloy.

4. (c)

5. (c)

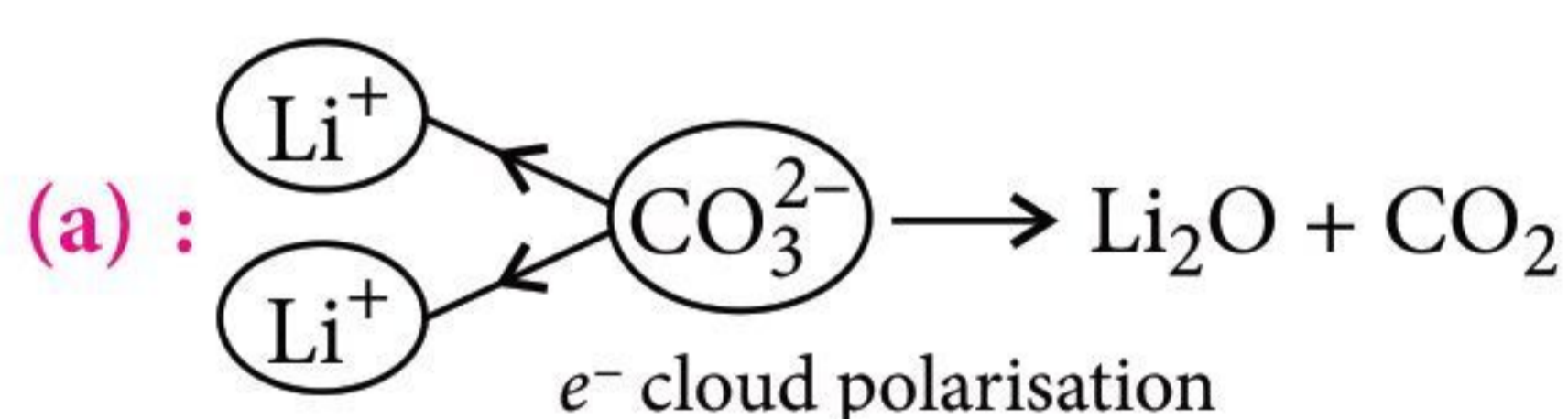
OR

(a) : Lindlar catalyst shows syn-addition.

6. (b) : LiCl is covalent in nature and thus soluble in weak polar organic solvents.

7. (c) : Atomic as well as ionic radii increase down the group. Hence ionic radii will show the trend :
 $\text{Cs}^+ > \text{Rb}^+ > \text{K}^+$

OR

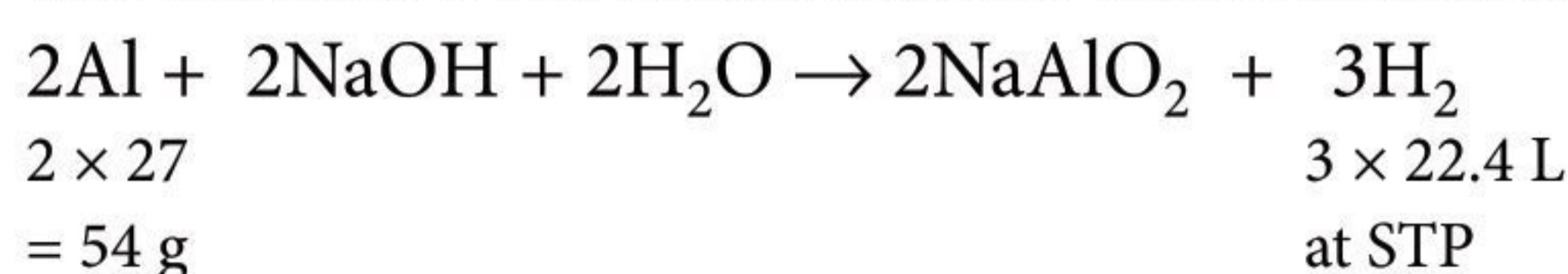


8. (d)

9. The value of van der Waals' constant a is a measure of attractive forces existing between the molecules of a given gas. These values suggest that van der Waals' forces of attraction are very weak in case of H_2 but are strong in case of NH_3 molecules.

OR

The reaction between aluminium and caustic soda is



54 g of Al produces H_2 at S.T.P. $= 3 \times 22.4 \text{ L}$

0.15 g of Al will produce H_2 at S.T.P.

$$= \frac{3 \times 22.4}{54} \times 0.15 = 0.186 \text{ L}$$

At STP

$p_1 = 1 \text{ atm}$

$V_1 = 0.186 \text{ L}$

$T_1 = 273 \text{ K}$

Given conditions

$p_2 = 1 \text{ bar} = 0.987 \text{ atm}$

$V_2 = ?$

$T_2 = 273 + 20 = 293 \text{ K}$

Applying ideal gas equation, $\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$

$$V_2 = \frac{293}{0.987} \times \frac{1 \times 0.186}{273} = 0.2023 \text{ L} = 202.3 \text{ mL}$$

10. (d) : The solubilities of BeSO_4 and MgSO_4 are high due to high energy of solvation of smaller Be^{2+} and Mg^{2+} ions. The value of solubility product decreases which explains decrease in solubility on moving down the group.

11. LiI is more soluble than KI in ethanol. Due to its small size, the lithium ion has a higher polarising power than potassium ion. It polarises the electron cloud of the iodide ion to a much greater extent than potassium ion. This causes a greater covalent character in LiI than KI. Hence, LiI is more soluble than KI in ethanol.

12. Molecular mass of alkane $= 72 \text{ g/mol}$.

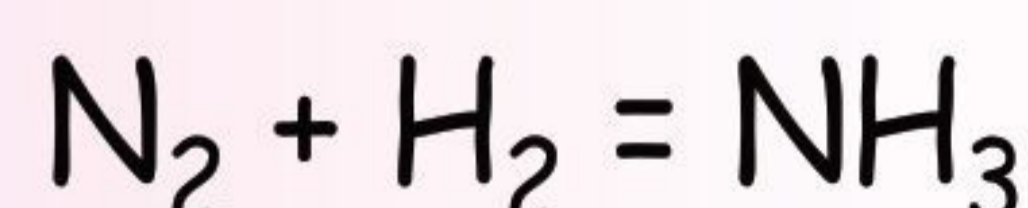
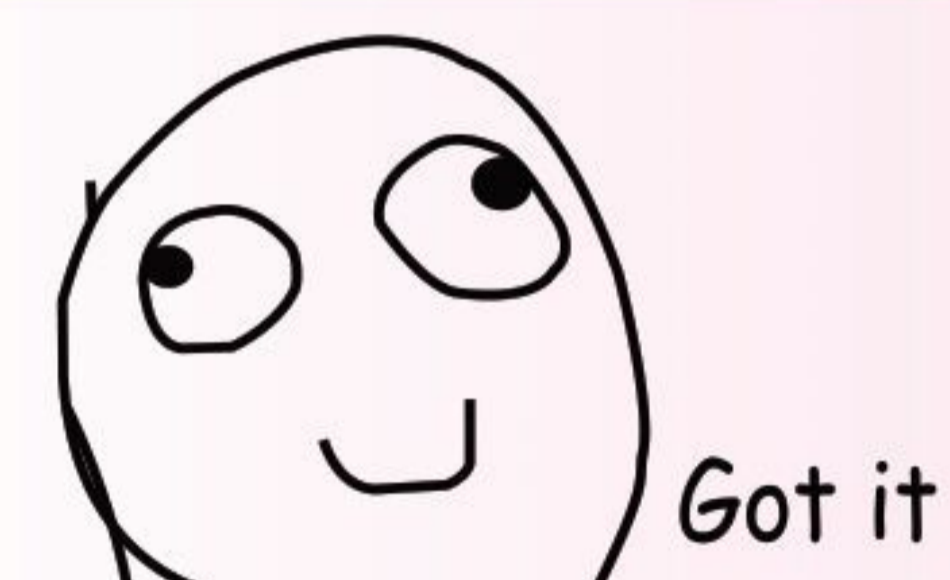
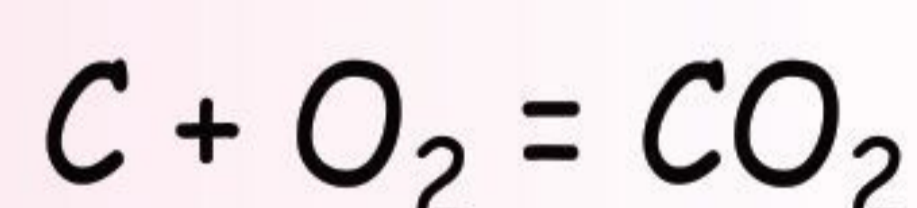
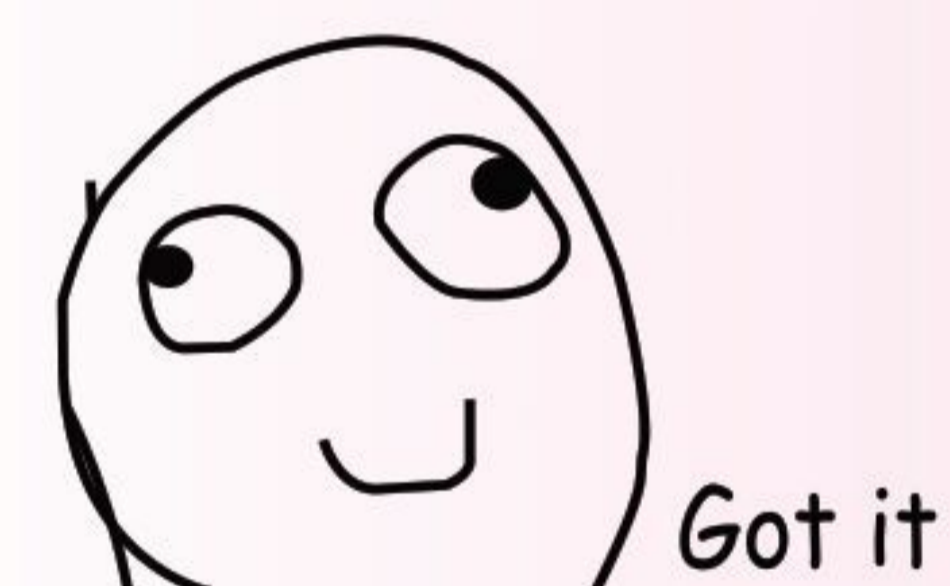
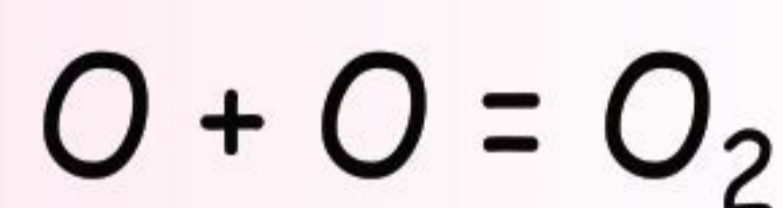
$$\Rightarrow \text{C}_n\text{H}_{2n+2} = 72 \text{ g/mol or } 12n + 2n + 2 = 72 \text{ or } n = 5,$$

So, the alkane is C_5H_{12} .



COMIC CAPSULE

ME LEARNING CHEMISTRY

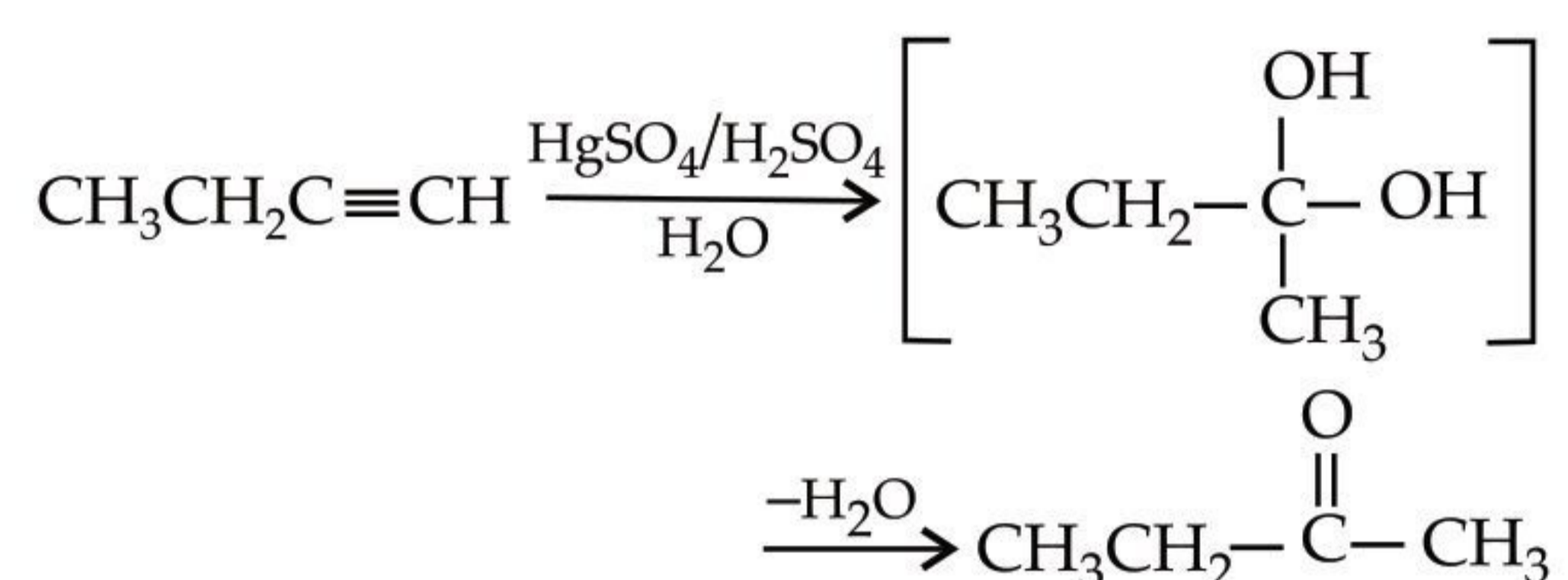


Structural isomers are :

- (i) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ (Pentane)
 (ii) $\text{CH}_3-\underset{\begin{array}{c} | \\ \text{CH}_3 \end{array}}{\text{CH}}-\text{CH}_2\text{CH}_3$ (2-Methylbutane)
 (iii) $\text{CH}_3-\underset{\begin{array}{c} | \\ \text{CH}_3 \end{array}}{\overset{\begin{array}{c} | \\ \text{CH}_3 \end{array}}{\text{C}}}-\text{CH}_3$ (2,2-Dimethylpropane)

OR

- (i) Hydration of alkynes via oxymercuration occurs according to Markownikoff's rule.

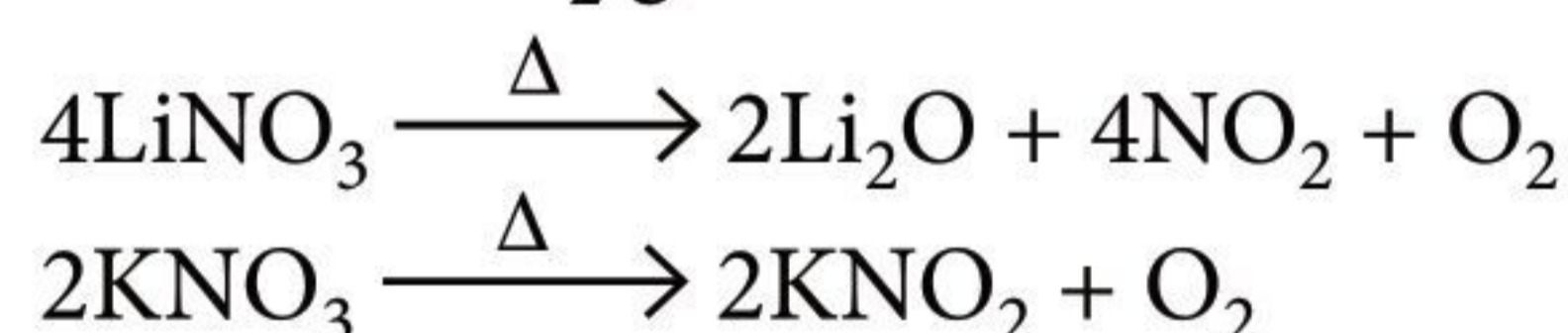


- (ii) Acetylene is a very weak acid thus, it does not react with NaOH or KOH but reacts with a very strong base such as NaNH_2 .

13. (i) Magnesium when heated in a flame does not impart any colour to the flame whereas calcium imparts a brick red colour to the flame.

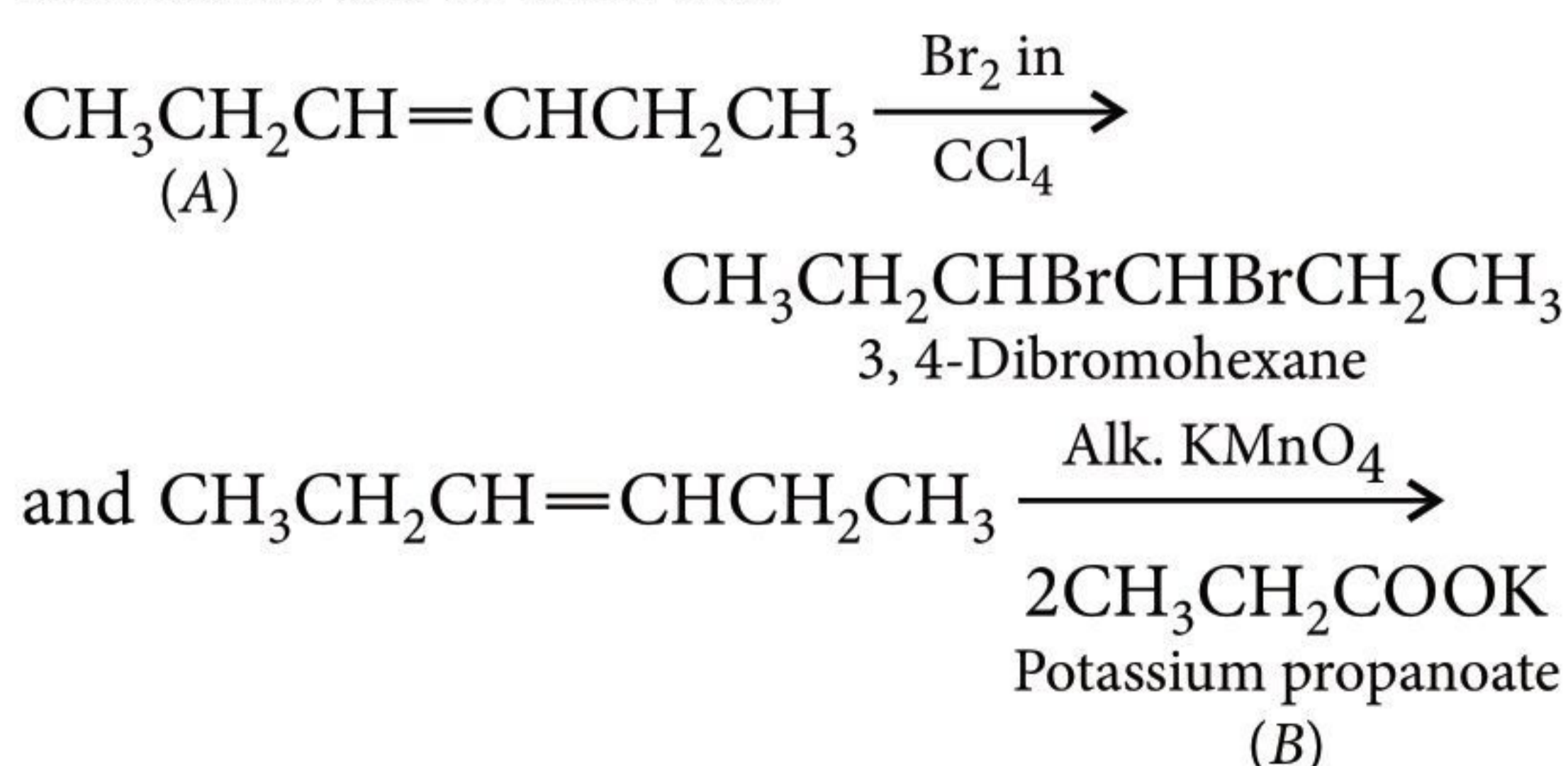
- (ii) Na_2CO_3 does not decompose, *i.e.*, stable towards heat but sodium bicarbonate decomposes to give CO_2 gas which turns lime water milky.

- (iii) LiNO_3 on heating gives brown fumes of NO_2 whereas KNO_3 on decomposition gives colourless O_2 gas.



14. The molecular formula C_6H_{12} suggests that the compound (A) may be an alkene or a cycloalkane. As (A) decolourises Br_2 dissolved in CCl_4 , it must be an alkene. Oxidation of (A) with alkaline KMnO_4 yields only one salt of an acid, the alkene (A) must be symmetrical, *i.e.*, hex-3-ene.

Reactions are as follows :



OR

- (i) Due to the presence of sp^3 hybridised carbon, the system is not planar hence, it is not aromatic.



- (ii) Cyclooctatetraene is tub-shaped *i.e.*, not planar and has 8π electrons. Therefore, the system is not aromatic.

15. (i) Since the volume of a gas at a constant temperature and pressure is proportional to the number of moles of the gas, the volume percentage of a gas in a mixture reflects its mole fraction.

$$\therefore x_{\text{N}_2} = \frac{70}{100} = 0.70, \quad x_{\text{O}_2} = \frac{25}{100} = 0.25 \text{ and}$$

$$x_{\text{CO}_2} = \frac{5}{100} = 0.05$$

- $\therefore p_{\text{N}_2} = x_{\text{N}_2} p = 0.70 \times 760 \text{ mm Hg} = 532 \text{ mm Hg}$
 $p_{\text{O}_2} = x_{\text{O}_2} p = 0.25 \times 760 \text{ mm Hg} = 190 \text{ mm Hg}$
 and

$$p_{\text{CO}_2} = x_{\text{CO}_2} p = 0.05 \times 760 \text{ mm Hg} = 38 \text{ mm Hg}$$

- (ii) The rate of effusion of a gas expressed in terms of the volume of the gas is directly proportional to the square root of its temperature and inversely proportional to the square root of its molecular mass.

$$\text{Thus, } r_{\text{He}} = \frac{16 \text{ mL}}{30 \text{ s}} \propto \sqrt{\frac{300 \text{ K}}{4}} \text{ and}$$

$$r_{\text{SO}_2} = \frac{V}{30 \text{ s}} \propto \sqrt{\frac{600 \text{ K}}{64}},$$

where V is the volume of SO_2 that effuses in 30 s.

$$\therefore \frac{r_{\text{SO}_2}}{r_{\text{He}}} = \frac{V}{30 \text{ s}} \times \frac{30 \text{ s}}{16 \text{ mL}} = \sqrt{\frac{600 \text{ K}}{64}} \times \sqrt{\frac{4}{300 \text{ K}}} = \frac{1}{2\sqrt{2}}$$

$$\Rightarrow V = \frac{16 \text{ mL}}{2\sqrt{2}} = 4\sqrt{2} \text{ mL} = 5.6 \text{ mL}$$

Hence, 5.6 mL of SO_2 will effuse through the crack in 30 s.

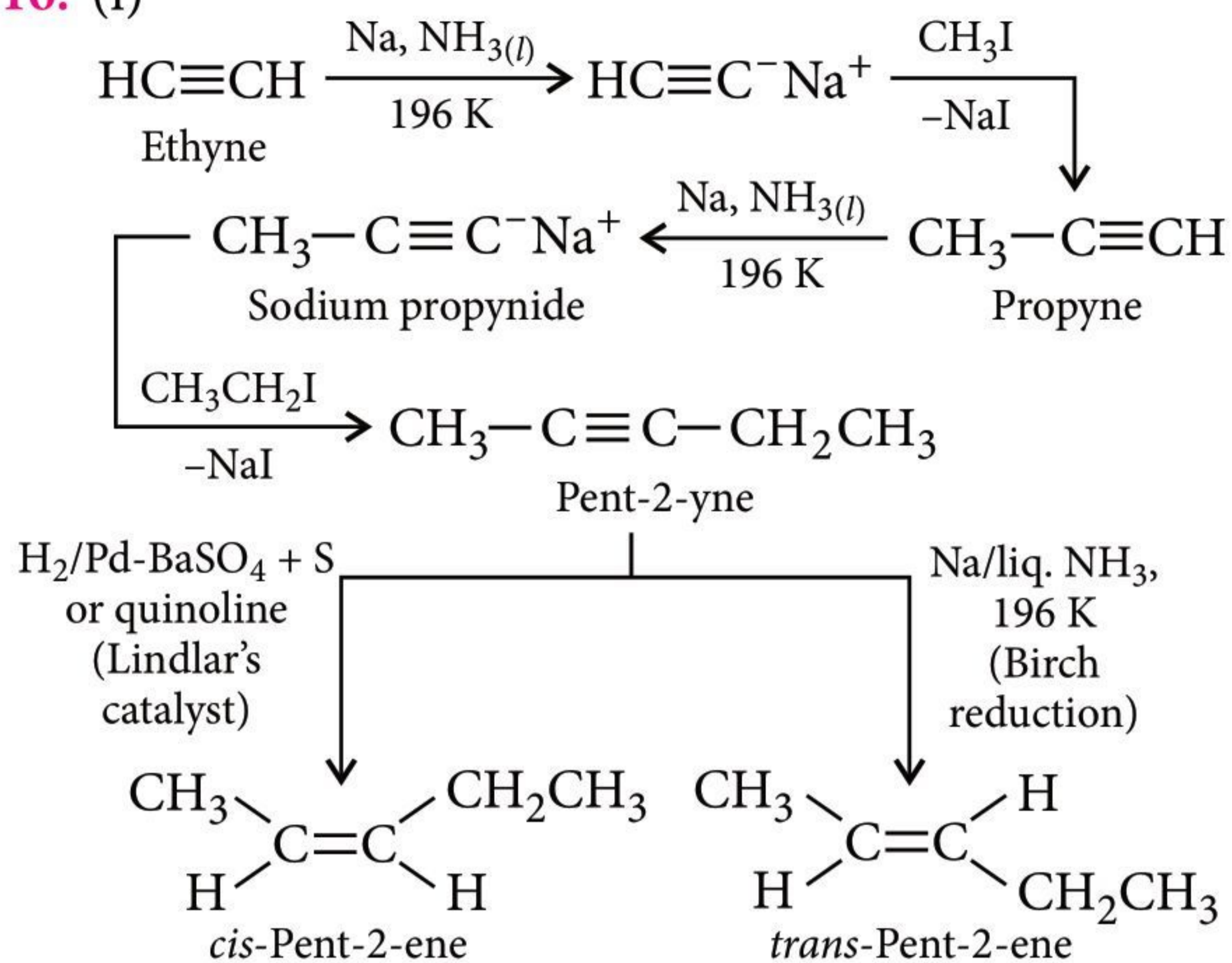
OR

- (i) Apply ideal gas equation, $pV = nRT$ to find out the solution.

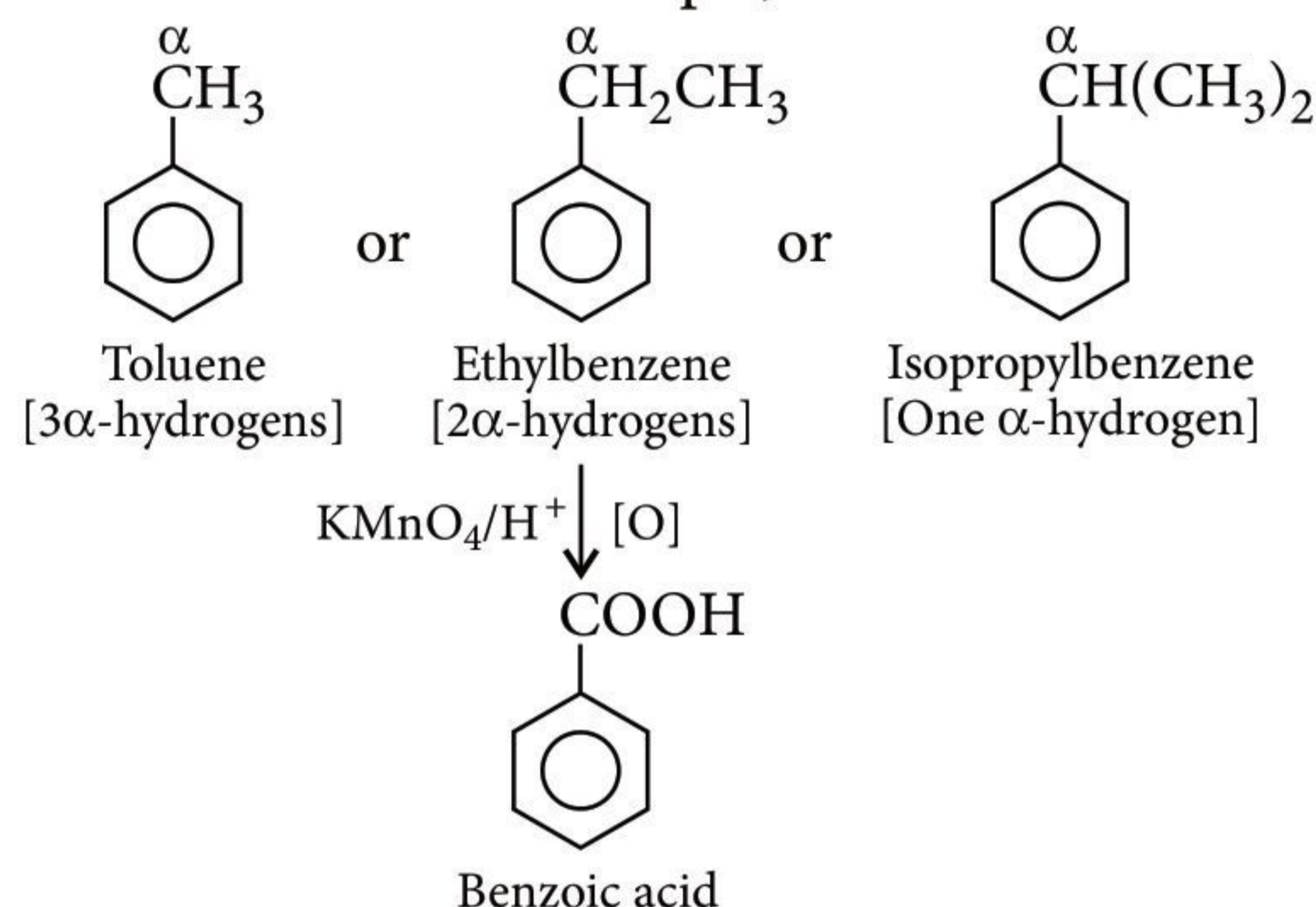
- (ii) At constant temperature,

$$p_1 V_1 = p_2 V_2; \quad p_2 = \frac{p_1 V_1}{V_2} = \frac{1 \times V_1}{4V_1} = 0.25 \text{ atm}$$

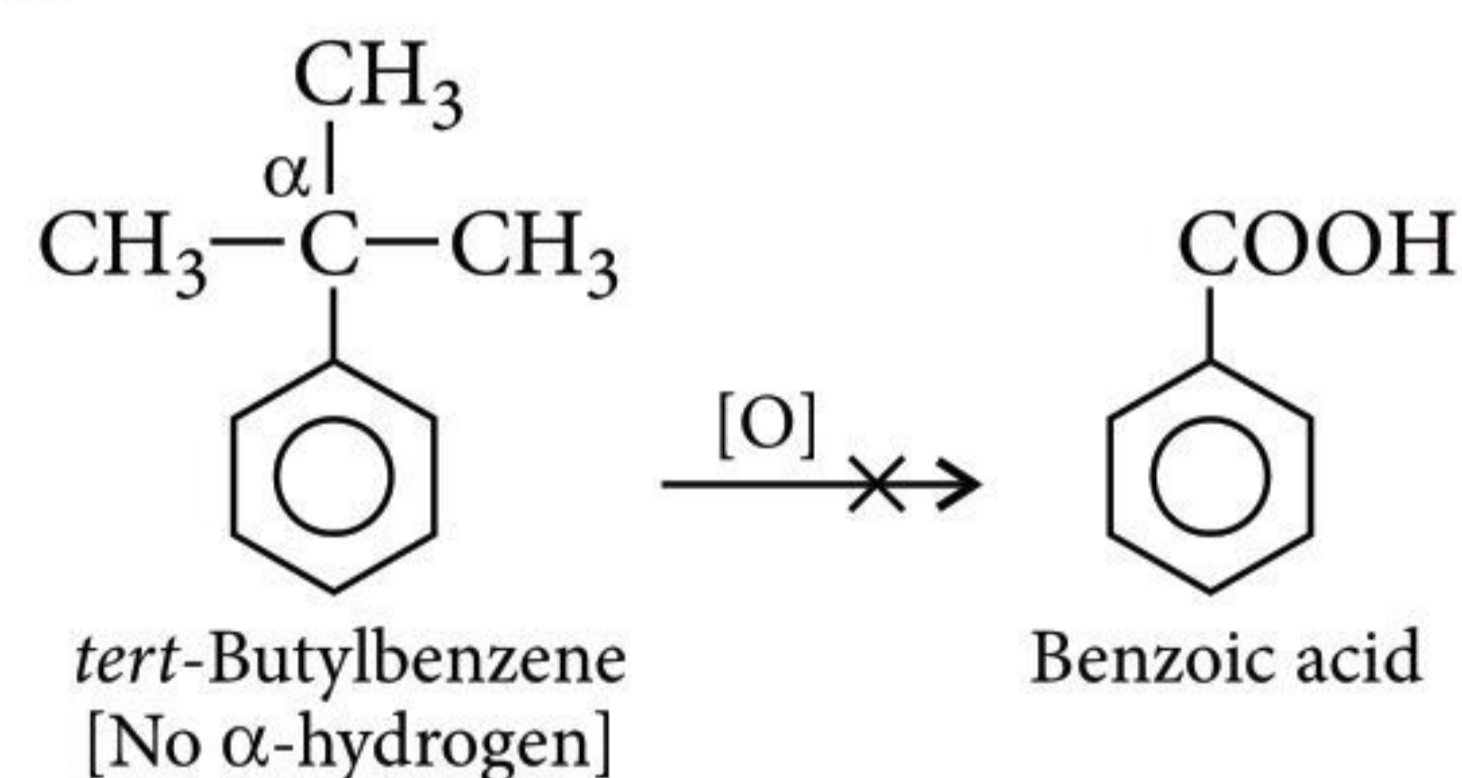
16. (i)



(ii) (a) Alkylbenzenes in which the alkyl groups contain one or more α -hydrogens or benzylic hydrogen on vigorous oxidation with acidic KMnO_4 ultimately give the corresponding benzoic acid irrespective of the length of the carbon chain. For example,



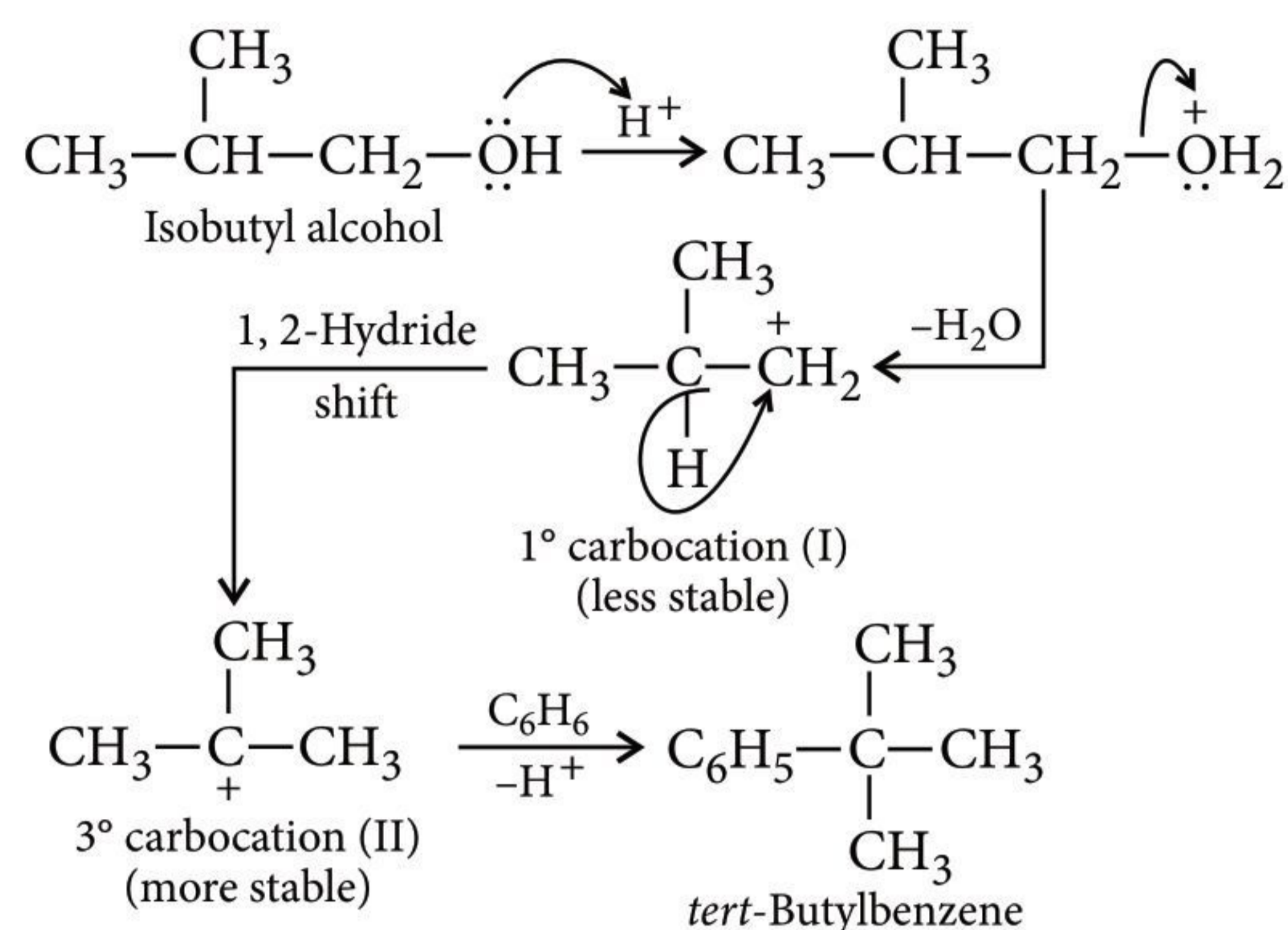
tert-Butylbenzene, on the other hand, does not contain any α -hydrogen or benzylic hydrogen and hence does not undergo oxidation easily to give benzoic acid.



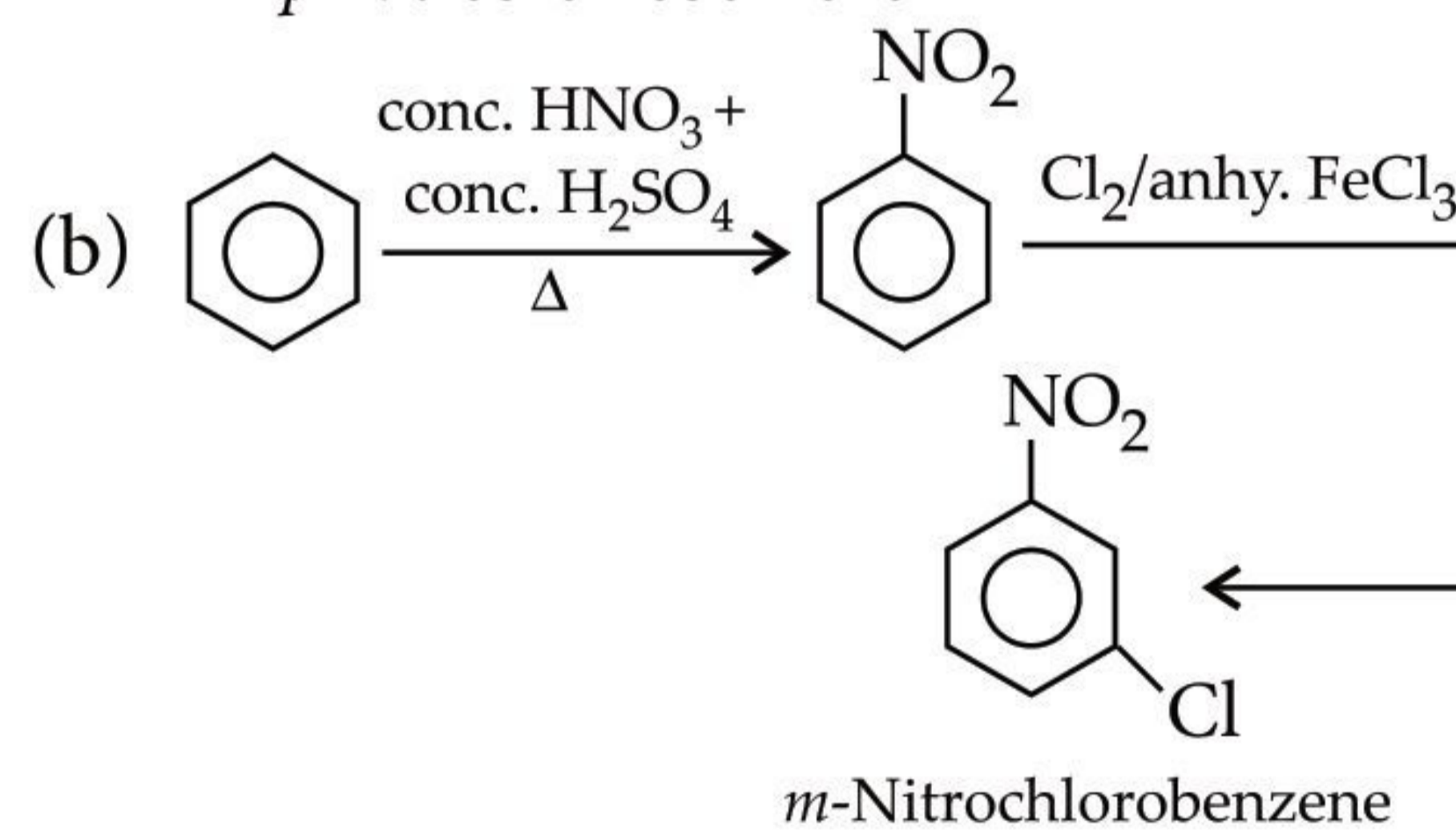
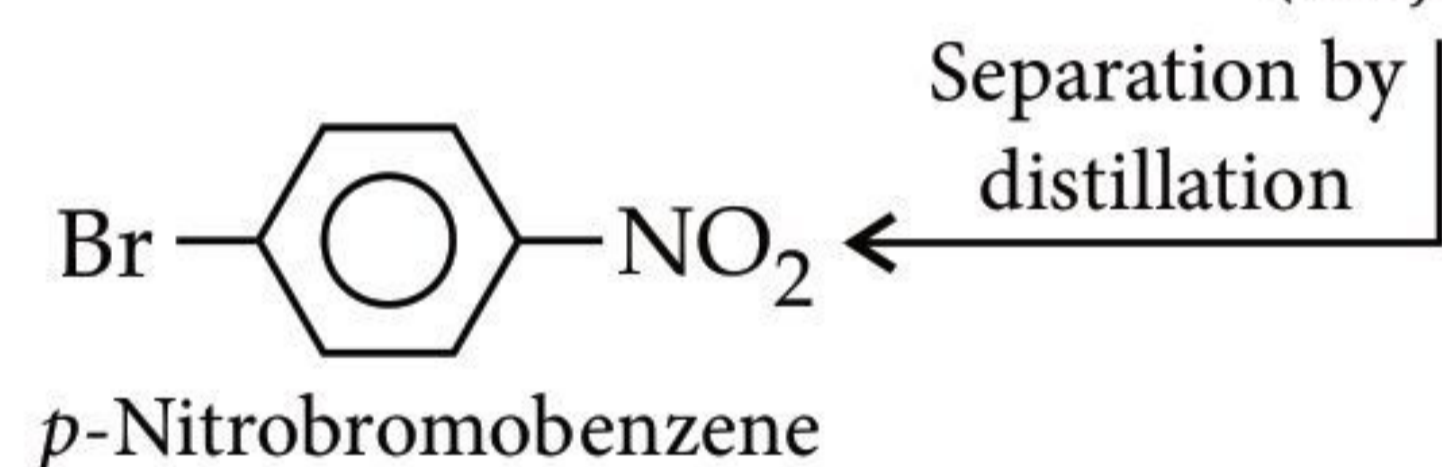
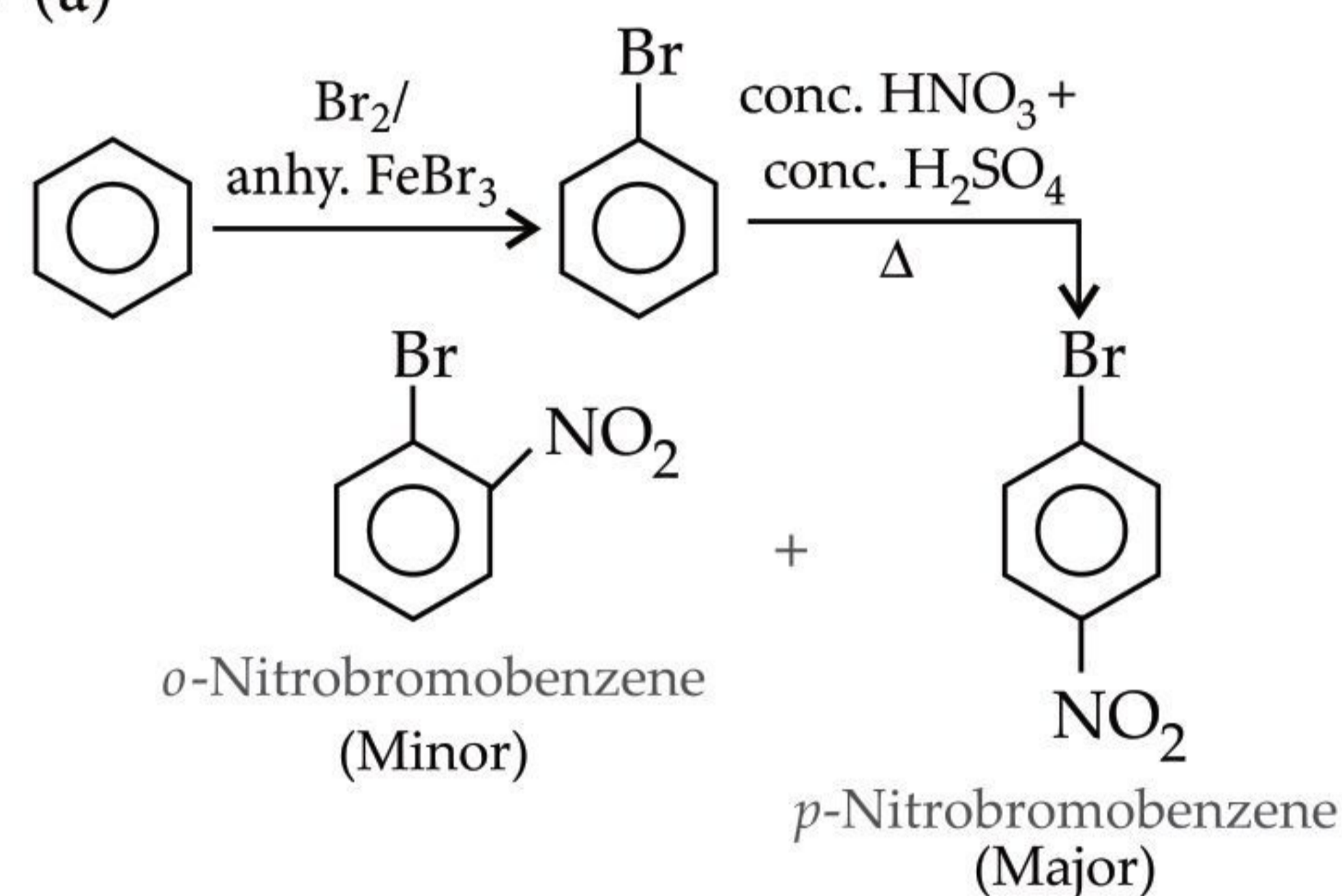
(b) $\text{CH}_2=\text{CH}^-$ is the conjugate base of the acid $\text{H}_2\text{C}=\text{CH}_2$ and $\text{HC}\equiv\text{C}^-$ is the conjugate base of the acid $\text{HC}\equiv\text{CH}$. We know that stronger the acid, weaker is the conjugate base. Since, $\text{HC}\equiv\text{CH}$ is stronger acid than $\text{CH}_2=\text{CH}_2$, therefore, $\text{CH}_2=\text{CH}^-$ is a stronger base than $\text{HC}\equiv\text{C}^-$.

OR

(i) In presence of conc. H_2SO_4 , isobutyl alcohol first gives 1° carbocation (I) which then rearranges to the more stable 3° carbocation (II) by 1, 2-hydride shift. Carbocation (II) then reacts with benzene to form *tert*-butylbenzene.



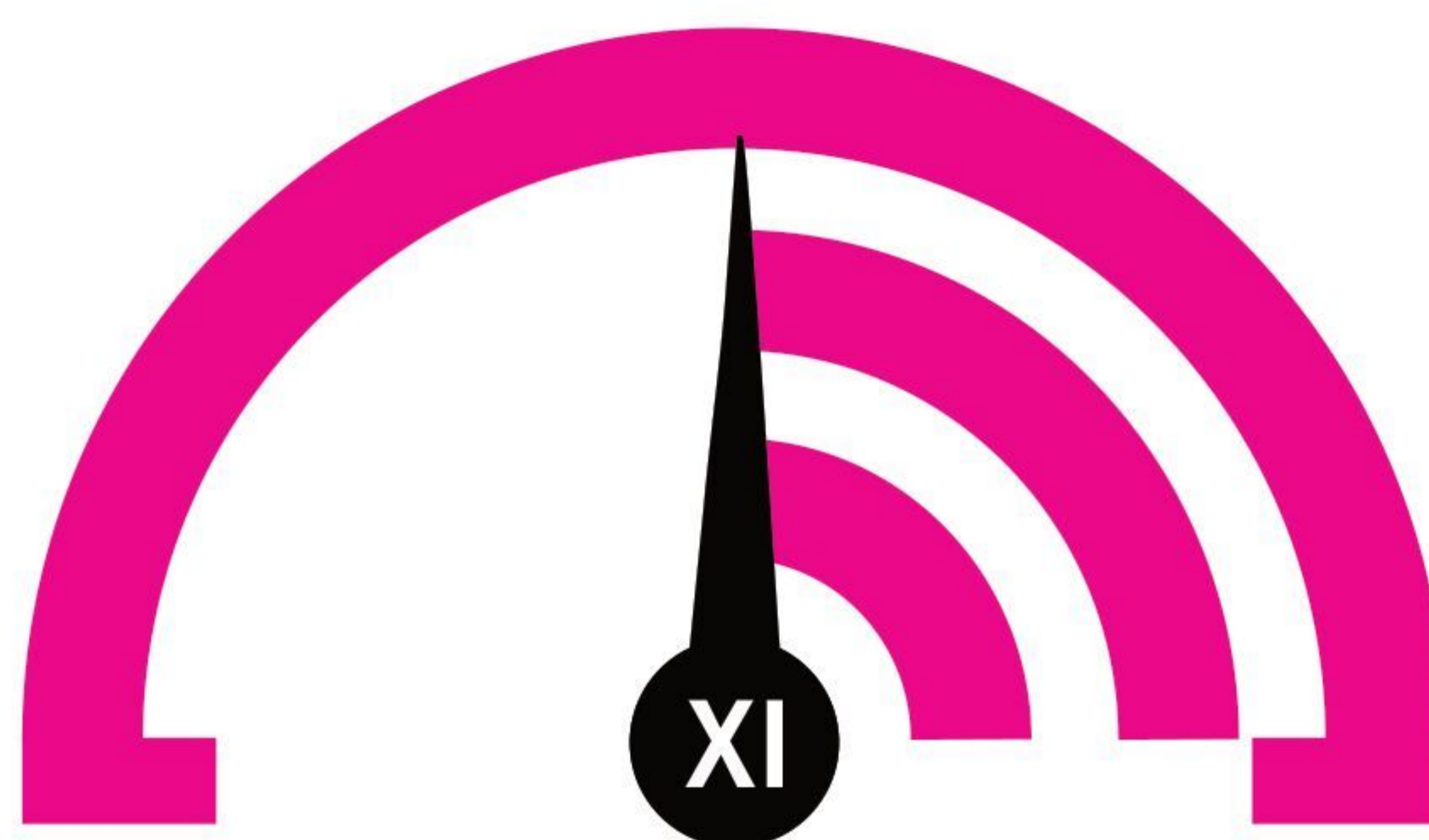
(ii) (a)



(iii) Due to the presence of electron cloud containing 6 π -electrons above and below the plane of the ring, benzene is a rich source of electrons. Consequently, it attracts the electrophiles towards it and repels nucleophiles. As a result, benzene undergoes electrophilic substitution reactions easily and nucleophilic substitution reactions with difficulty.



MONTHLY TEST DRIVE



This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120

Classification of Elements and Periodicity in Properties | Chemical Bonding and Molecular Structure

Time Taken : 60 Min.

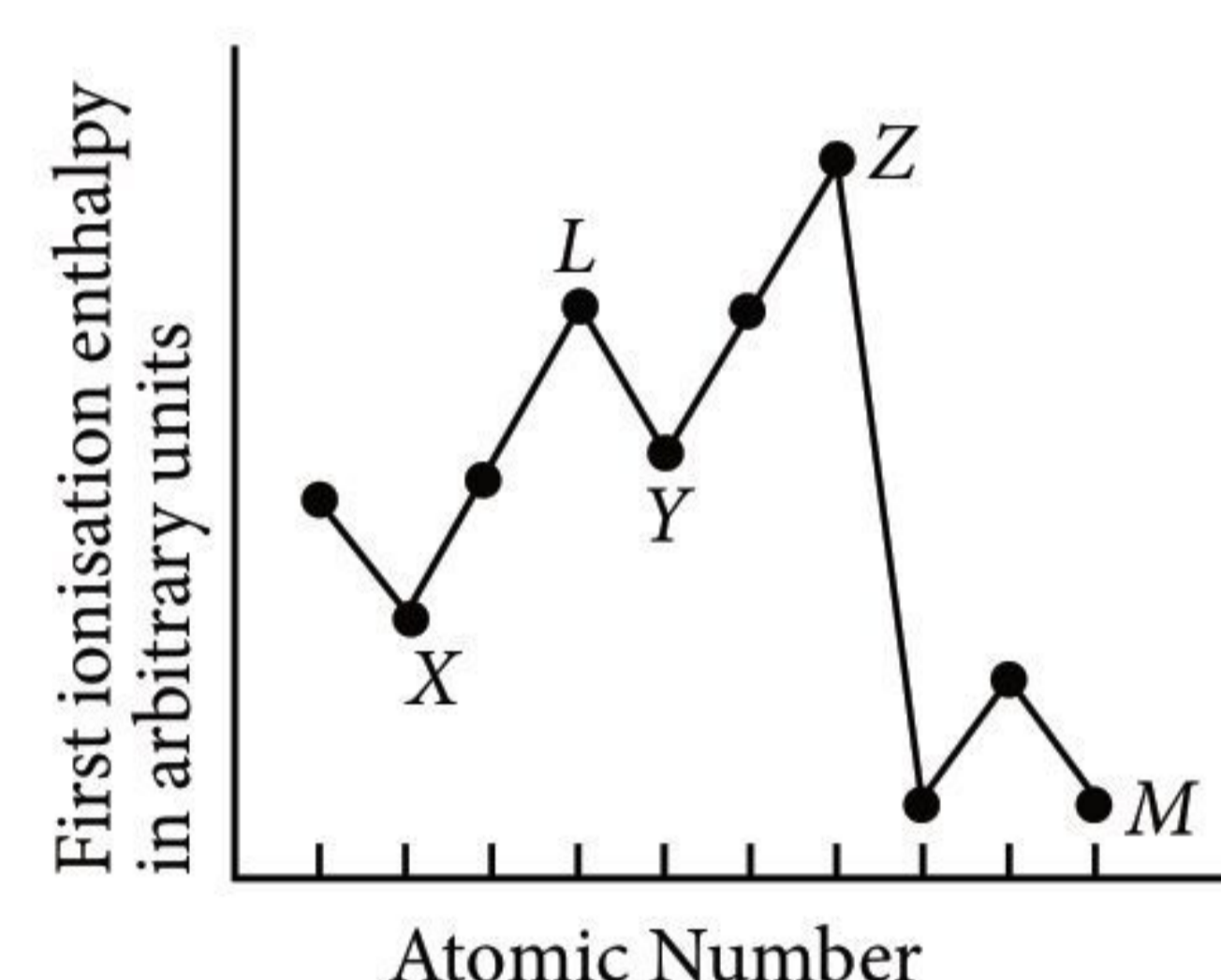
NEET

Only One Option Correct Type

- The ionic size of Na^+ , Mg^{2+} , Al^{3+} and Si^{4+} follows the order :
 (a) $\text{Na}^+ < \text{Mg}^{2+} < \text{Al}^{3+} < \text{Si}^{4+}$
 (b) $\text{Na}^+ > \text{Mg}^{2+} > \text{Al}^{3+} > \text{Si}^{4+}$
 (c) $\text{Na}^+ > \text{Mg}^{2+} < \text{Al}^{3+} < \text{Si}^{4+}$
 (d) $\text{Na}^+ < \text{Mg}^{2+} > \text{Al}^{3+} > \text{Si}^{4+}$
- In which of the following compounds does the ratio of anion size to the cation size have the lowest value?
 (a) NaCl (b) KCl
 (c) MgCl_2 (d) NaBr
- The dipole moment of lithium hydride is $1.962 \times 10^{-29} \text{ Cm}$ and interatomic distance between Li and H in the molecule is 0.1592 nm. Calculate the percentage ionic character of the molecule.
 (a) 50% (b) 77% (c) 84% (d) 25%
- Which of the following combinations of atomic orbitals will give antibonding π -molecular orbital (assume z-axis as internuclear axis)?
 (a) $2s + 2p_z$ (b) $2p_y + 2p_y$
 (c) $2p_x - 2p_x$ (d) $2p_z - 2p_z$
- The formation of oxide ion, $\text{O}_{(g)}^{2-}$ requires first an exothermic and then an endothermic step as shown below.
 $\text{O}_{(g)} + e^- \rightarrow \text{O}_{(g)}^- ; \Delta H^\circ = -142 \text{ kJ mol}^{-1}$
 $\text{O}_{(g)}^- + e^- \rightarrow \text{O}_{(g)}^{2-} ; \Delta H^\circ = +844 \text{ kJ mol}^{-1}$
 This is because
 (a) oxygen is more electronegative
 (b) oxygen has high electron affinity

- O^- will tend to resist the addition of another electron
- O^- ion has comparatively larger size than oxygen atom.

- In the graph below, the one which represents an alkali metal with the higher atomic number is
 (a) Y
 (b) Z
 (c) L
 (d) M



- The correct set of four quantum numbers for the valence electrons of rubidium ($Z = 37$) is
 (a) $5, 0, 1, +\frac{1}{2}$ (b) $5, 0, 0, +\frac{1}{2}$
 (c) $5, 1, 0, +\frac{1}{2}$ (d) $5, 1, 1, +\frac{1}{2}$
- Which of the following is not a correct resonating structure for carbon dioxide?
 (a) $\text{O} = \text{C} = \text{O}$ (b) $^-\text{O} - \text{C} \equiv \text{O}^+$
 (c) $^+\text{O} - \text{C} = \text{O}^-$ (d) None of the above
- The first ($\Delta_i H_1$) and second ($\Delta_i H_2$) ionization enthalpies (in kJ mol^{-1}) and the electron gain enthalpy ($\Delta_{eg} H$) (in kJ mol^{-1}) of the elements I, II, III, IV and V are given below.

Element	$\Delta_i H_1$	$\Delta_i H_2$	$\Delta_{eg} H$
I	520	7300	-60
II	419	3051	-48
III	1681	3374	-328
IV	1008	1846	-295
V	2372	5251	+48

The most reactive metal and the least reactive non-metal of these are respectively

- (a) I and V (b) V and II
(c) II and V (d) IV and V

10. Which of the following is paramagnetic?

- (a) O_2 (b) CN^- (c) CO (d) NO^+

11. The electronic configuration of four elements are

- (i) $[Xe]6s^1$ (ii) $[Xe]4f^{14}5d^16s^2$
(iii) $[Ne]3s^23p^5$ (iv) $[Ar]3d^74s^2$

Select the incorrect match about these elements.

- (a) (i) – a strong reducing agent
(b) (ii) – a *d*-block element
(c) (iii) – high magnitude of $\Delta_{eg}H$
(d) (iv) – exhibits variable oxidation states

12. The first ionisation energy of oxygen is less than that of nitrogen. Which of the following is the correct reason for this observation?

- (a) Lesser effective nuclear charge of oxygen than nitrogen.
(b) Lesser atomic size of oxygen than nitrogen.
(c) Greater interelectronic repulsion between two electrons in the same *p*-orbital which counterbalances the increase in effective nuclear charge on moving from nitrogen to oxygen
(d) Greater effective nuclear charge of oxygen than nitrogen.

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** The elements having $1s^22s^22p^63s^2$ and $1s^22s^2$ configuration belong to same group.

Reason : These have same number of valence electrons.

14. **Assertion :** Among the two O—H bonds in H_2O molecule, the energy required to break the first O—H bond and the other O—H bond is same.

Reason : This is because the electronic environment around oxygen is the same even after breaking of one O—H bond.

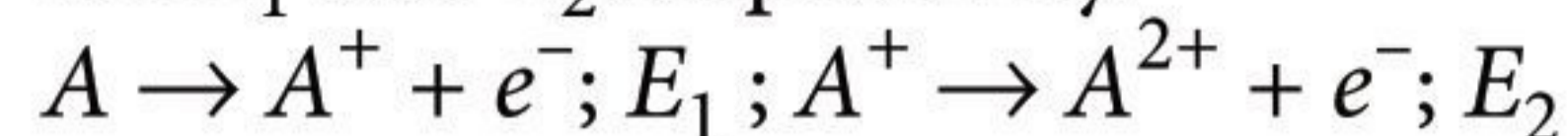
15. **Assertion :** Both BF_3 and PF_5 do not obey octet rule.

Reason : Both are electron deficient molecules.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. The energy required to pull out the two electrons are E_1 and E_2 respectively.



The correct relationship between the two energies would be

- (a) $E_1 < E_2$ (b) $E_1 > E_2$
(c) $E_1 = E_2$ (d) cannot be predicted.

17. The correct order of bond order values among the following species is

- (i) NO^- (ii) NO^+ (iii) NO (iv) NO^{2+}
(v) NO^{2-}
(a) (i) < (iv) < (iii) < (ii) < (v)
(b) (iv) = (ii) < (i) < (v) < (iii)
(c) (v) < (i) < (iv) = (iii) < (ii)
(d) (ii) < (iii) < (iv) < (i) < (v)

18. Select the incorrect statement(s) about C_2 molecule.

- (a) It exists in vapour phase.
(b) It contains 12 electrons out of which 8 are present in bonding orbitals and 4 in antibonding orbitals.
(c) It is paramagnetic in nature.
(d) It is diamagnetic in nature.

19. Four diatomic species are listed below in different sequences. Which of these represents the correct order of their increasing bond orders?

- (a) $C_2^{2-} < He_2^+ < NO < O_2^-$
(b) $He_2^+ < O_2^- < NO < C_2^{2-}$
(c) $O_2^- < NO < C_2^{2-} < He_2^+$
(d) $NO < C_2^{2-} < O_2^- < He_2^+$

More than One Options Correct Type

20. Which of the following statements are correct about CO_3^{2-} ?

- (a) The hybridisation of central atom is sp^3 .
(b) Its resonance structure has one C—O single bond and two C=O double bonds.
(c) The average formal charge on each oxygen atom is 0.67 units.
(d) All C—O bond lengths are equal.

21. Hydrogen bonding plays a central role in the following phenomena :

- (a) Ice floats in water
(b) Higher Lewis basicity of primary amines than tertiary amines in aqueous solutions.
(c) Formic acid is more acidic than acetic acid.
(d) Dimerisation of acetic acid in benzene.

22. In which of the following sets of ions Z/e decreases? Here, e is number of electrons.

- (a) I^+ , I , I^- (b) Fe^{3+} , Fe^{2+} , Fe
(c) Mg^{2+} , Ne , F^- (d) F , Ne , Mg^{2+}

23. Which of the following is/are correct statement(s)?

- (a) The electron affinity of Si is greater than that of P.
(b) Penetrating power of p -orbital is more than s -orbital.
(c) The numerical value of electronegativity of an atom depends on its ionisation potential and electron affinity.
(d) The radius of a cation of an element is greater than the radius of anion of same element.

Integer / Numerical Value Type

24. The formal charge of each atom in sulphuric acid is equal to_____.

25. The successive ionisation energy values for an element X are given below :

1st ionisation energy = 410 kJ mol⁻¹

2nd ionisation energy = 820 kJ mol⁻¹

3rd ionisation energy = 1100 kJ mol⁻¹

4th ionisation energy = 1500 kJ mol⁻¹

5th ionisation energy = 3200 kJ mol⁻¹

The number of valence electrons for the atom X is_____.

26. The element with maximum electronegativity belongs to period_____.

Comprehension Type

There are many observable patterns in the physical and chemical properties of elements like, atomic and ionic radii, ionisation enthalpy, electron gain enthalpy, electronegativity, valence and chemical reactivity as we descend in a group or move across a period in the periodic table. The periodicity is related to the electronic configuration. That is, all chemical and physical properties are a manifestation of the electronic configuration of elements.

27. Which of the following is incorrect order regarding the property indicated?

(a) $Sc^{3+} > Cr^{3+} > Fe^{3+} > Mn^{3+}$ – Ionic radius

(b) $Sc < Ti < Cr < Mn$ – Density

(c) $Mn^{2+} > Ni^{2+} < Co^{2+} < Fe^{2+}$ – Ionic radius

(d) $FeO < CaO > MnO > CuO$ – Basic nature

28. The electronic configurations of four elements are given below :

(i) $2s^2 2p^5$ (ii) $3s^2 3p^5$ (iii) $2s^2 2p^4$ (iv) $3s^2 3p^4$

The correct order of the magnitude (without sign) of their electron gain enthalpy is

(a) (i) < (ii) < (iv) < (iii) (b) (ii) < (i) < (iv) < (iii)

(c) (iii) < (iv) < (ii) < (i) (d) (iii) < (iv) < (i) < (ii)

Matrix Match Type

29. **Column I** **Column II**

(A) He (P) High negative electron gain enthalpy

(B) Cl (Q) Strongly electropositive element

(C) Ca (R) Strongest reducing agent

(D) Li (S) Highest ionization enthalpy

The correct match of the contents in column I with those in column II is

(a) A-P, B-Q, C-S, D-R

(b) A-Q, B-P, C-S, D-R

(c) A-P, B-Q, C-R, D-S

(d) A-S, B-P, C-Q, D-R

30. Match the List I (species) with List II (shape) and choose the correct matching codes from the choices given below.

List I

A. PCl_5

B. IF_7

C. H_3O^+

D. ClO_2^-

E. NH_4^+

List II

1. Linear

2. Pyramidal

3. Trigonal bipyramidal

4. Tetrahedral

5. Pentagonal bipyramidal

6. Angular

(a) A-3, B-5, C-2, D-1, E-4

(b) A-3, B-5, C-4, D-1, E-2

(c) A-3, B-5, C-6, D-1, E-2

(d) A-3, B-5, C-2, D-6, E-4



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No. of questions correct

Marks scored in percentage

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1. Given the following data pertaining to an aqueous solution, pick the correct statement.

Couple	E° (in V)
$\text{Cr}^{3+} / \text{Cr}^{2+}$	-0.41
$\text{Fe}^{3+} / \text{Fe}^{2+}$	+0.77
$\text{Co}^{3+} / \text{Co}^{2+}$	+1.97

- (a) Cr^{3+} is more stable than Cr^{2+}
 (b) Co^{3+} is more stable than Co^{2+}
 (c) Co^{3+} is a weaker oxidant than Fe^{3+}
 (d) Fe^{2+} is a stronger reductant than Cr^{2+}
2. A 0.0020 m aqueous solution of an ionic compound, $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}$, freezes at -0.00732°C . The number of moles of ions that 1 mol of the ionic compound produces on being dissolved in water is ($K_f = 1.86^\circ\text{C/m}$)
 (a) 2 (b) 3 (c) 4 (d) 1
3. Platinum(IV) forms the following compounds with ammonia.
 I. $\text{PtCl}_4 \cdot 6\text{NH}_3$ II. $\text{PtCl}_4 \cdot 5\text{NH}_3$
 III. $\text{PtCl}_4 \cdot 4\text{NH}_3$ IV. $\text{PtCl}_4 \cdot 3\text{NH}_3$
 V. $\text{PtCl}_4 \cdot 2\text{NH}_3$
 1 mol of which of the following compounds will give 2 mol of HCl on being treated with concentrated H_2SO_4 ?

- (a) I and II only (b) II and III only
 (c) III, IV and V only (d) III only

4. Match the column I with column II and mark the appropriate choice.

Column I	Column II
(i) $(\text{CH}_3)_2\text{CHOH}$	(A) Antifreeze
(ii) Glycol	(B) Anaesthetic
(iii) Carbolic acid	(C) Disinfectant
(iv) Diethyl ether	(D) Rubbing alcohol

- (a) (i) \rightarrow (D), (ii) \rightarrow (A), (iii) \rightarrow (C), (iv) \rightarrow (B)
 (b) (i) \rightarrow (A), (ii) \rightarrow (D), (iii) \rightarrow (B), (iv) \rightarrow (C)
 (c) (i) \rightarrow (B), (ii) \rightarrow (A), (iii) \rightarrow (C), (iv) \rightarrow (D)
 (d) (i) \rightarrow (C), (ii) \rightarrow (D), (iii) \rightarrow (A), (iv) \rightarrow (B)

5. In the reaction
 $\text{CH}_3\text{COOH} \xrightarrow[\text{H}_2\text{O}]{\text{Red P}_4/\text{Cl}_2} (\text{A}) \xrightarrow{\text{NaCN}} (\text{B}) \xrightarrow{\text{H}_2\text{O}/\text{H}^+} (\text{C})$

the product C is

- (a) $\begin{array}{c} \text{CH}_2 - \text{COOH} \\ | \\ \text{CH}_2 - \text{COOH} \end{array}$ (b) $\begin{array}{c} \text{CH}_2 - \text{CO} \\ | \quad \diagup \quad \diagdown \\ \text{CH}_2 - \text{CO} \quad \text{O} \end{array}$
 (c) $\begin{array}{c} \text{COOH} \\ \diagup \quad \diagdown \\ \text{CH}_2 \\ \diagdown \quad \diagup \\ \text{COOH} \end{array}$ (d) $\begin{array}{c} \text{CONH}_2 \\ \diagup \quad \diagdown \\ \text{CH}_2 \\ \diagdown \quad \diagup \\ \text{COOH} \end{array}$

6. The polymer in which the intermolecular force of attraction is weakest, is

(a) nylon (b) polyvinyl chloride
(c) polythene (d) natural rubber.

7. The time required for 10% completion of a first order reaction at 298 K is equal to that required for its 25% completion at 308 K. If the pre-exponential factor for the reaction is $3.56 \times 10^9 \text{ s}^{-1}$, calculate its rate constant at 318 K.

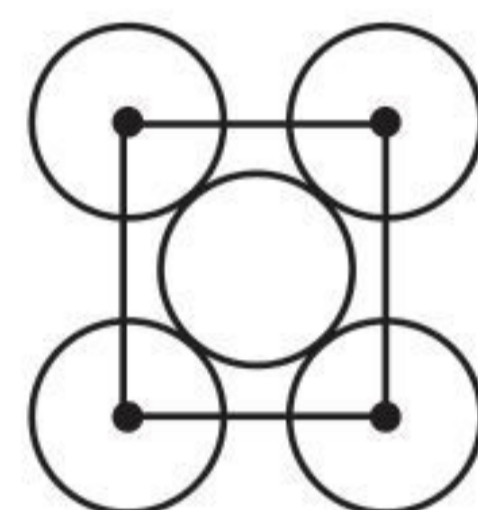
(a) $0.92 \times 10^{-4} \text{ s}^{-1}$ (b) $9.22 \times 10^{-4} \text{ s}^{-1}$
(c) $92.2 \times 10^{-4} \text{ s}^{-1}$ (d) $92 \times 10^{-4} \text{ s}^{-1}$

8. Aniline is treated with bromine water to give an organic compound 'X' which when treated with NaNO_2 and HCl at 0°C gives a water soluble compound 'Y'. Compound 'Y' on treatment with Cu_2Cl_2 and HCl gives compound 'Z'. Compound 'Z' is

(a) *o*-bromochlorobenzene
(b) *p*-bromochlorobenzene
(c) 2, 4, 6-tribromophenol
(d) 2, 4, 6-tribromochlorobenzene.

9. The packing efficiency of the two dimensional square unit cell shown is

(a) 39.27% (b) 68.02%
(c) 74.05% (d) 78.54%



10. The gold number of some colloidal solutions are given as :

Colloidal solution	Gold number
A	0.01
B	2.5
C	20

The protective nature of these colloidal solutions follows the order

(a) $C > B > A$ (b) $A > B > C$
(c) $A = B = C$ (d) $B > A > C$

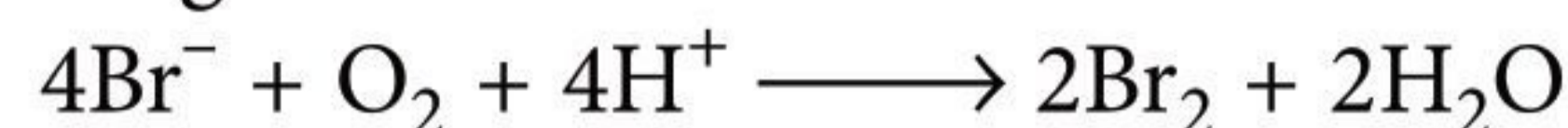
11. In Ramsay and Rayleigh's isolation of noble gases from air, the nitrogen of the air is finally converted into

(a) NaNO_2 only (b) NO and NO_2
(c) NaNO_3 only (d) NaNO_2 and NaNO_3

12. Which of the following statement is not correct?

(a) Monosaccharides reduce Tollen's reagent.
(b) On dissolving α -D-glucose in water having specific rotation 111° , its specific rotation decreases.
(c) Glucose is aldohexose while fructose is ketohexose.
(d) In the open chain structure of D-glucose, $-\text{OH}$ group is present on the left at 5th carbon atom.

13. Calculate the value of equilibrium constant for the following cell reaction:



Given that, $E^\circ_{\text{cell}} = 0.16 \text{ V}$.

(a) 10.84 (b) 7.03×10^{10}
(c) 15.59 (d) 3.92×10^{15}

14. In the metallurgy of iron, when limestone is added to the blast furnace, the calcium ions end up in

(a) gangue (b) slag
(c) metallic calcium (d) calcium oxide.

15. **Assertion** : Aryl iodides can be prepared by simply shaking of diazonium salt with potassium iodide.

Reason : Alkyl halides are colourless when pure. However, bromides and iodides develop colour when exposed to light.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is NOT the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Both assertion and reason are false.

SOLUTIONS

1. (a): A negative reduction potential indicates that the species has a tendency to lose electrons *i.e.*, Cr^{3+} is more stable than Cr^{2+} .

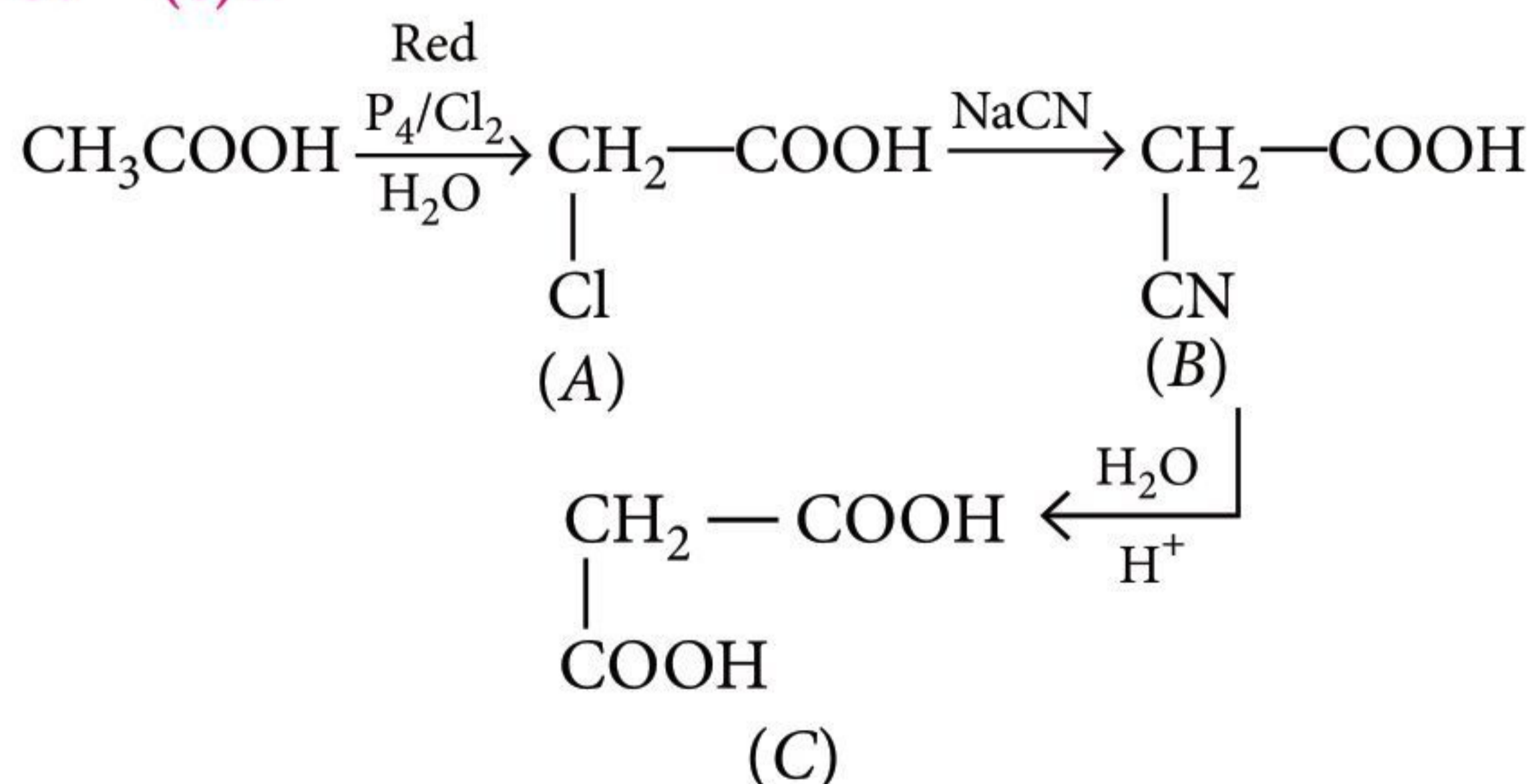
2. (a): $\Delta T_f = K_f m = 1.86^\circ\text{C}/\text{m} \times 0.0020 \text{ m}$
 $= 0.00373^\circ\text{C}$

$$\therefore i = \frac{(\Delta T_f)_{\text{obs.}}}{(\Delta T_f)_{\text{calc.}}} = \frac{0.00732^\circ\text{C}}{0.00373^\circ\text{C}} = 1.96 \approx 2 \Rightarrow n = 2$$

3. (d)

4. (a)

5. (c):



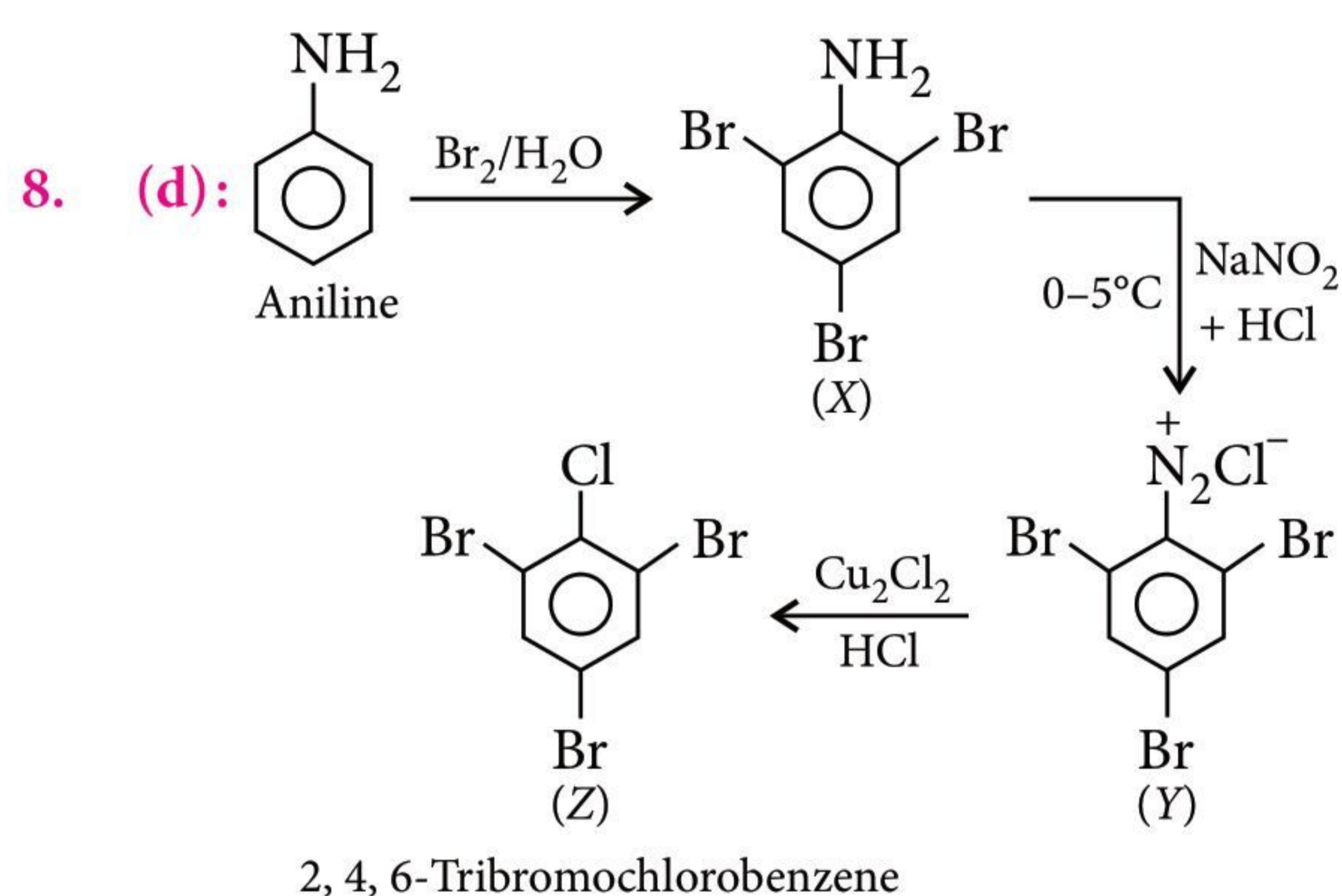
6. (d): Natural rubber has the weakest intermolecular forces among the given polymers *i.e.*, consist of van der Waals' forces of attraction and is an example of an elastomer.

7. (b): Given, $t = \frac{2.303}{k_{298}} \log_{10} \frac{100}{90} = \frac{2.303}{k_{308}} \log_{10} \frac{100}{75}$
 $\therefore \frac{k_{308}}{k_{298}} = 2.73$

Also, $2.303 \log_{10} \frac{k_{308}}{k_{298}} = \frac{E_a}{R} \left[\frac{T_2 - T_1}{T_1 T_2} \right]$
 $\therefore 2.303 \log_{10} 2.73 = \frac{E_a}{8.314} \times \frac{10}{298 \times 308}$
 $\therefore E_a = 76.6227 \text{ kJ mol}^{-1}$

Now, $k = Ae^{-E_a/RT}$

$k_{318} = 3.56 \times 10^9 \times e^{-76622.7/(8.314 \times 318)}$
 $= 3.56 \times 10^9 \times 2.59 \times 10^{-13} = 9.22 \times 10^{-4} \text{ sec}^{-1}$



9. (d): $4R = \sqrt{2} L$

so, $L = 2\sqrt{2}R$

Area of square unit cell = $(2\sqrt{2}R)^2$
 $= 8R^2$

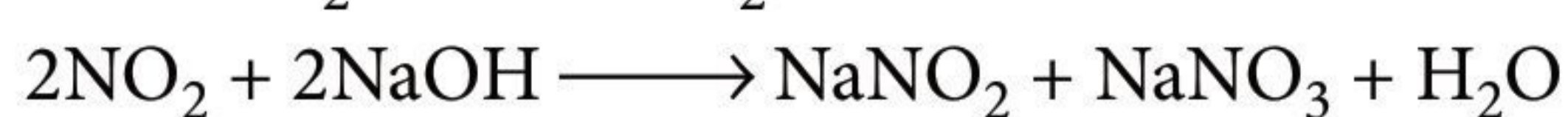
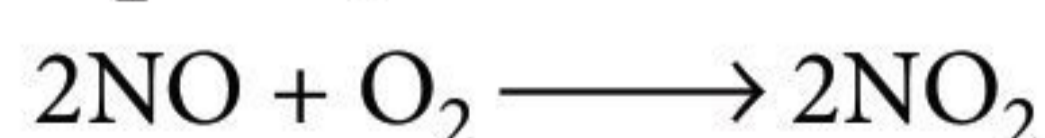
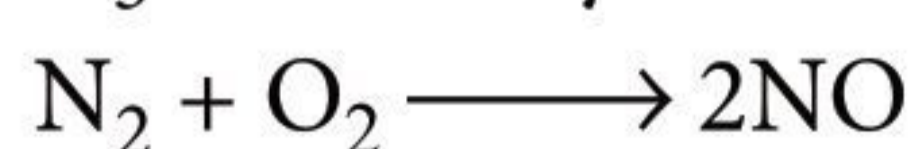
Area of unit cell occupied by atoms

$= \pi R^2 + 4 \left(\frac{\pi R^2}{4} \right) = 2\pi R^2$

So, packing efficiency = $\frac{2\pi R^2}{8R^2} \times 100\% = \frac{\pi}{4} \times 100\%$
 $\approx 78.54\%$

10. (b): Higher the gold number, lower will be the protective power of a colloidal solution.

11. (d): Nitrogen is finally converted into NaNO_2 and NaNO_3 in Ramsay and Rayleigh's method.



12. (d)

13. (b): E°_{cell} is related to equilibrium constant K_c as:

$E^\circ_{\text{cell}} = \frac{0.059}{n} \log K_c$ or $\log K_c = \frac{nE^\circ_{\text{cell}}}{0.059}$

In this reaction, four electrons are transferred so, $n = 4$

$\log K_c = \frac{4 \times 0.16 \text{ V}}{0.059 \text{ V}} = 10.847$

$K_c = 7.03 \times 10^{10}$

14. (b)

15. (b)



Omicron : Know the Reality

Omicron's rapid rise in South Africa is what worries researchers most, because it suggests the variant could spark explosive increases in COVID-19 cases elsewhere. On 1st December, South Africa recorded 8,561 cases up from the 3,402 reported on 26 November and several hundred per day in mid-November, with much of the growth occurring in Gauteng Province, home to Johannesburg.

Researchers will be watching how Omicron spreads in other parts of South Africa and globally to get a better read on its transmissibility, says epidemiologist.

Transmissibility : It is not yet clear whether Omicron is more transmissible (e.g., more easily spread from person to person) compared to other variants, including Delta. The number of people testing positive has risen in areas of South Africa affected by this variant, but epidemiologic studies are underway to understand if it is because of Omicron or other factors.

Severity of disease : It is not yet clear whether infection with Omicron causes more severe disease compared to infections with other variants, including Delta. Preliminary data suggests that there are increasing rates of hospitalization in South Africa, but this may be due to increasing overall numbers of people becoming infected, rather than a result of specific infection with Omicron.

Effectiveness of vaccines : WHO is working with technical partners to understand the potential impact of this variant on existing countermeasures, including vaccines. Vaccines remain critical to reducing severe disease and death, including against the dominant circulating variant, Delta. **Current vaccines remain effective against severe disease and death.**

Effectiveness of current tests : The widely used PCR tests continue to detect infection, including infection with Omicron, as we have seen with other variants as well. Studies are ongoing to determine whether there is any impact on other types of tests, including rapid antigen detection tests.

Effectiveness of current treatments : Corticosteroids and IL6 Receptor Blockers will still be effective for managing patients with severe COVID-19. Other treatments will be assessed to see if they are still as effective given the changes to parts of the virus in the Omicron variant.

Recommended actions for people : The most effective steps individuals can take to reduce the spread of the COVID-19 virus is to keep a physical distance of at least 1 metre from others; wear a well-fitting mask; open windows to improve ventilation; avoid poorly ventilated or crowded spaces; keep hands clean; cough or sneeze into a bent elbow or tissue; and get vaccinated when it's their turn.

THERMODYNAMICS

Properties of System

Physical quantities which are used to define the system.

Intensive properties: These do not depend upon quantity of matter. *e.g.*, T , P .

Extensive properties: These depend upon quantity of matter. *e.g.*, mass, volume, energy.

Thermodynamic Processes

- If $dq=0$, process is adiabatic.
- If $dT=0$ and $dE=0$, the process is isothermal.
- If $dV=0$, process is isochoric.
- If $dP=0$, process is isobaric.

Heat (q) and Heat Capacity (C)

- Heat capacity, $C = dq/dT$
- $C_v = \left(\frac{\partial U}{\partial T}\right)_v$; $C_p = \left(\frac{\partial H}{\partial T}\right)_p$
- When n_1 moles of gas A and n_2 moles of gas B are mixed.

$$(C_v)_{\text{mix}} = \frac{n_1 C_{v1} + n_2 C_{v2}}{n_1 + n_2}$$
- $C_p - C_v = R$

Work (W)

- $W = -P_{\text{ext}}\Delta V$
[Irreversible isothermal expansion]
- $W = -2.303nRT \log(P_1/P_2)$
- $W = -2.303nRT \log(V_2/V_1)$
[Reversible isothermal expansion]
- $W = nC_v dT = \frac{nR}{\gamma-1}(T_2 - T_1)$
[Reversible adiabatic expansion]
where, $\gamma = C_p/C_v$
- $W = -P_{\text{ext}}R \left(\frac{T_2 P_1 - T_1 P_2}{P_1 P_2} \right)$
[Irreversible adiabatic expansion]

Enthalpy (H)

Total heat of the system

- $H = U + PV$
- $\Delta H = \Delta U + P\Delta V = nC_p \Delta T$
 $= \Delta U + \Delta n_g RT$ (at constant pressure)
- $\Delta H = \sum H_{\text{product}} - \sum H_{\text{reactant}}$
 $= -ve$ (exothermic reaction)
 $= +ve$ (endothermic reaction)

Thermodynamic Laws

Zeroth law: If two thermodynamic systems are each in thermal equilibrium with a third one, then they are in thermal equilibrium with each other.

First law: The total energy of the universe remains constant although it may undergo transformation from one form to the other.
 $\Delta U = q + w$ (ΔU = internal energy)

Second law: In a spontaneous process total energy of the universe increases.

$$\Delta S_{\text{universe}} = \Delta S_{\text{system}} + \Delta S_{\text{surrounding}} > 0$$

Third law

- Entropy of all pure crystals is zero at the absolute zero temperature.
 $\lim_{T \rightarrow 0} S = 0$
- Residual Entropy, $S_R = k \ln W$
 $(W = \text{thermodynamic probability})$

ELECTROCHEMISTRY

Basic Terms

- Conductance:** Reciprocal of resistance.
 $C = \frac{1}{R}$; Unit: Ω^{-1} or S
- Conductivity:** Conductance of 1 cm³ of the conductor.
 $\kappa = C \times \frac{l}{a}$; Unit: $\Omega^{-1} \text{ cm}^{-1}$ or S cm⁻¹
- Equivalent conductivity:** Conductance of a solution containing 1 g-equivalent of an electrolyte dissolved in V cm³ of the solution.
 $\Lambda_{\text{eq}} = \frac{\kappa \times 1000}{\text{Normality}}$; Unit: S cm² eq⁻¹
- Molar conductivity:** Conductance of a solution containing 1 mole of an electrolyte dissolved in V cm³ of the solution.
 $\Lambda_m = \frac{\kappa \times 1000}{\text{Molarity}}$; Unit: S cm² mol⁻¹
- Electrode potential:** Tendency of an electrode to lose or gain electrons when it is in contact with solution of its own ions.
- Cell potential or EMF of the cell:** The difference between electrode potentials of two half-cells.

Types of Cells

- Electrochemical cell:** Device used to convert chemical energy of a redox reaction into electrical energy.
- Electrolytic cell:** Device which uses electricity to bring about a non-spontaneous redox reaction.

Laws

- Faraday's first law:** $W = Zit$
- Faraday's second law:** $\frac{W_1}{W_2} = \frac{E_1}{E_2}$
- Kohlrausch's law:** For an electrolyte $A_x B_y$,
 $\Lambda_m^\circ = x\lambda_{A^+}^\circ + y\lambda_{B^-}^\circ$ or $\Lambda_m^\circ = \lambda_{A^+}^\circ + \lambda_{B^-}^\circ$

Commercial Cells/Batteries

- Primary cells** cannot be recharged. *e.g.*, dry cell, mercury cell.
- Secondary cells** can be recharged. *e.g.*, lead storage battery, Ni-Cd storage cell.
- Fuel cells** convert the energy produced during combustion of fuels into electrical energy directly. *e.g.*, H₂-O₂ fuel cell.

Gibbs Free Energy (G)

Useful work done by the system

- $G = H - TS$
- $\Delta G = \Delta H - T\Delta S$
(Gibbs - Helmholtz equation)
- $\Delta G^\circ = \sum G_{f(\text{product})}^\circ - \sum G_{f(\text{reactant})}^\circ$
- $\Delta G^\circ = -2.303 RT \log K_{\text{eq}}$
- If for a reaction:
 $\Delta G = +ve$ (Non-spontaneous)
 $\Delta G = -ve$ (Spontaneous)

Entropy (S)

Measure of randomness or disorder

- $\Delta S = \frac{q_{\text{rev}}}{T}$ (Reversible process)
- $\Delta S = 2.303n C_v \log\left(\frac{T_2}{T_1}\right) + 2.303nR \log\left(\frac{V_2}{V_1}\right)$

CHEMICAL KINETICS

Rate of Reaction

- For a reaction, $aA + bB \rightarrow xX + yY$

$$\text{Rate} = -\frac{1}{a} \frac{d[A]}{dt} = -\frac{1}{b} \frac{d[B]}{dt} = +\frac{1}{x} \frac{d[X]}{dt} = +\frac{1}{y} \frac{d[Y]}{dt}$$
- Greater the concentration of reactants, faster is the reaction.
- Rate becomes double for every 10° rise in temperature.
- Greater the surface area of reactants, faster is the reaction.

Order and Molecularity

- For a rate law equation, $\text{rate} = k[A]^a[B]^b$
 Order of reaction = $a + b$
- Molecularity** is the number of atoms, ions or molecules that must collide simultaneously with one another to result into a chemical reaction.

Integrated Rate Equation and Half-Life

Order	Integrated rate equation	Half-life ($t_{1/2}$)
0	$[A]_t = -kt + [A]_0$	$[A]_0/2k$
1	$\ln[A]_t = -kt + \ln[A]_0$	$0.693/k$
2	$1/[A]_t = kt + 1/[A]_0$	$1/k[A]_0$
2	$kt = \frac{1}{[A]_0 - [B]_0} \ln \frac{[B]_0[A]}{[A]_0[B]}$	-
n	$(n-1)kt = \frac{1}{[A]^{n-1}} - \frac{1}{[A]_0^{n-1}}$	$\frac{2^{n-1} - 1}{k(n-1)[A]_0^{n-1}}$

- Relationship between time for different fractions of a first order reaction to complete,
 $t_{3/4}$ or $t_{75\%} = 2t_{1/2}$
 $t_{87.5\%} = 3t_{1/2} = \frac{3}{2}t_{75\%}$
 $t_{93.75\%} = 4t_{1/2} = 2t_{75\%}$
 $t_{96.87\%} = 5t_{1/2}$; $t_{99.9\%} = 10t_{1/2}$

Temperature Dependence of Rate of Reaction and Effect of Catalyst

- Arrhenius equation:** $k = Ae^{-E_a/RT}$
 or $\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[\frac{T_2 - T_1}{T_1 T_2} \right]$
- Activation energy
 $= \text{Threshold energy} - \text{Average kinetic energy of reactants}$
- Collision theory:** $\text{Rate} = PZe^{-E_a/RT}$
 where, P is steric factor and Z is collision frequency.
- Catalyst** increases the rate of a reaction without itself undergoing any permanent chemical change.

Nernst Equation and Electrochemical Series

- Nernst equation:** For the reaction:
 $M^{n+} + ne^- \rightarrow M$,
 $E = E^\circ - \frac{RT}{nF} \ln \frac{M}{[M^{n+}]}$ or
 $E = E^\circ - \frac{0.0591}{n} \log \frac{1}{[M^{n+}]}$ at 298 K
- For concentration cell:**
 $E_{\text{cell}} = \frac{0.0591}{n} \log \frac{C_2}{C_1}$; $E_{\text{cell}} = +ve$ if $C_2 > C_1$
- For a reaction in equilibrium:**
 $E_{\text{cell}}^\circ = \frac{0.0591}{n} \log K$ at 298 K
- Electrochemical series:** It is the arrangement of electrodes in order of increasing standard reduction potentials and helps in comparing the relative oxidizing or reducing powers.

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CLASS-XII

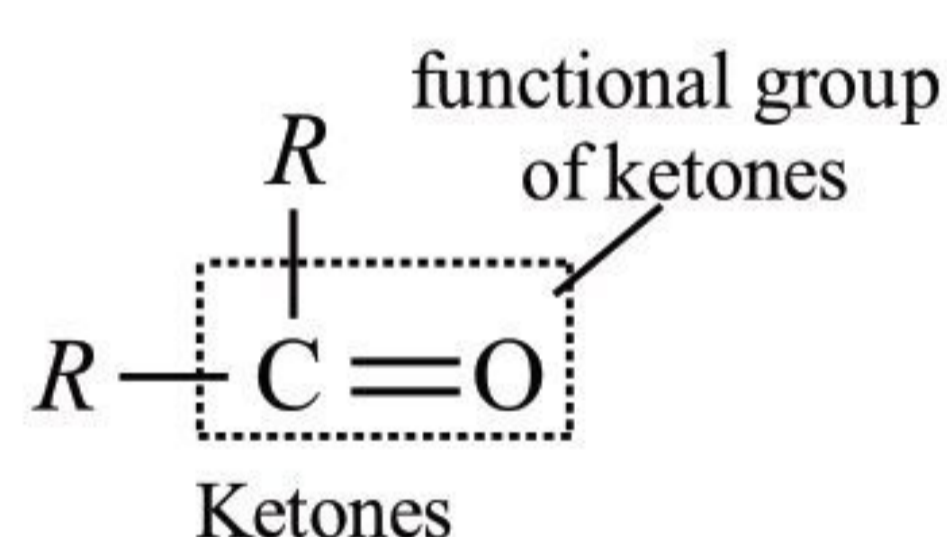
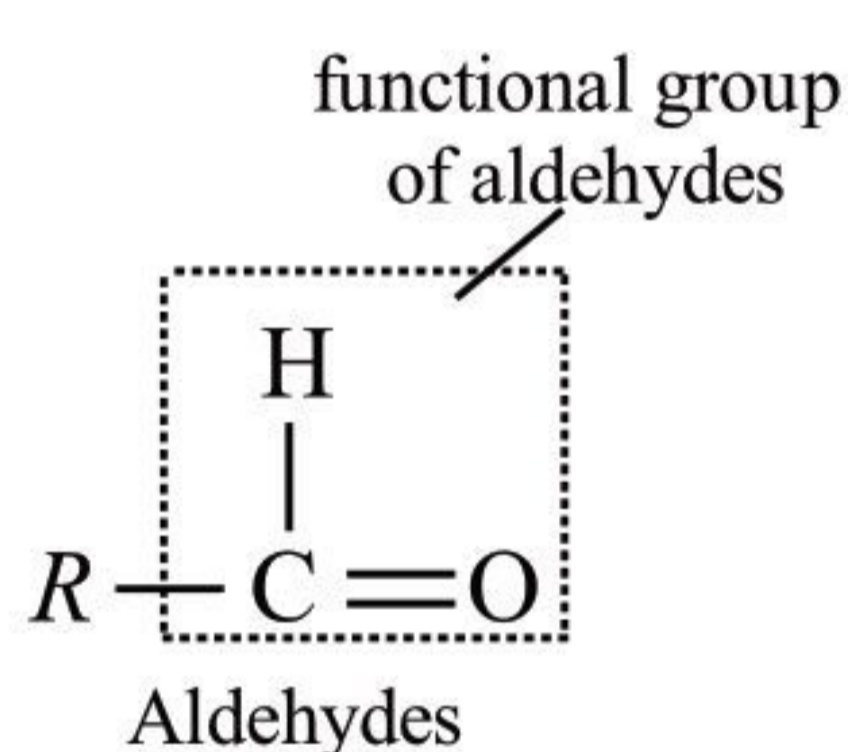
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Unit
7

Aldehydes, Ketones and Carboxylic Acids | Organic Compounds Containing Nitrogen

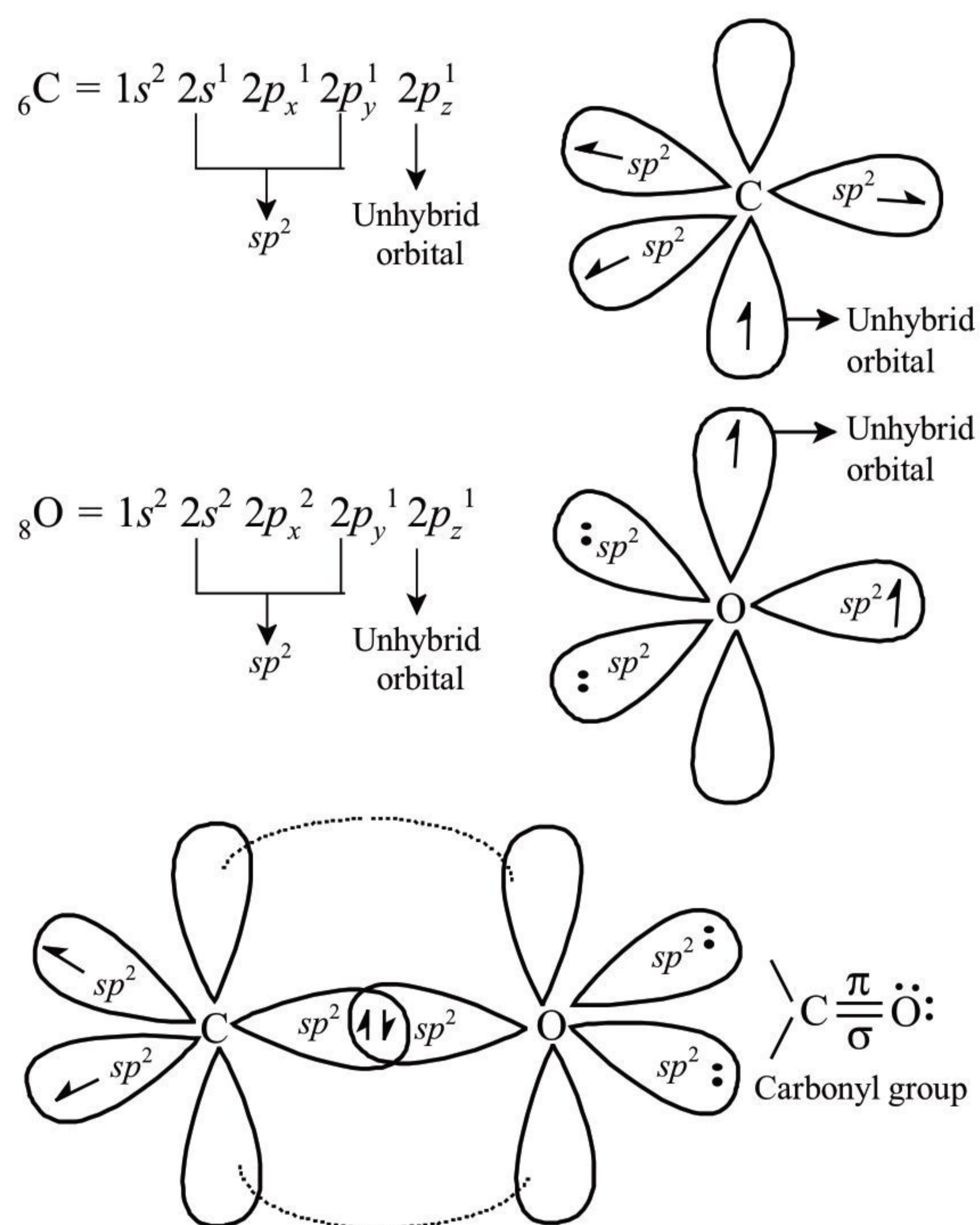
Aldehydes and Ketones

- Aldehydes are the compounds having general formula $RCHO$ and ketones are compounds having general formula $RCOR'$. The groups R and R' may be aliphatic or aromatic.
- Both aldehydes and ketones contain a carbon-oxygen double bond ($>C=O$). This unit is referred as carbonyl group ($>C=O$) and aldehydes and ketones are collectively called as carbonyl compounds.



STRUCTURE OF CARBONYL GROUP

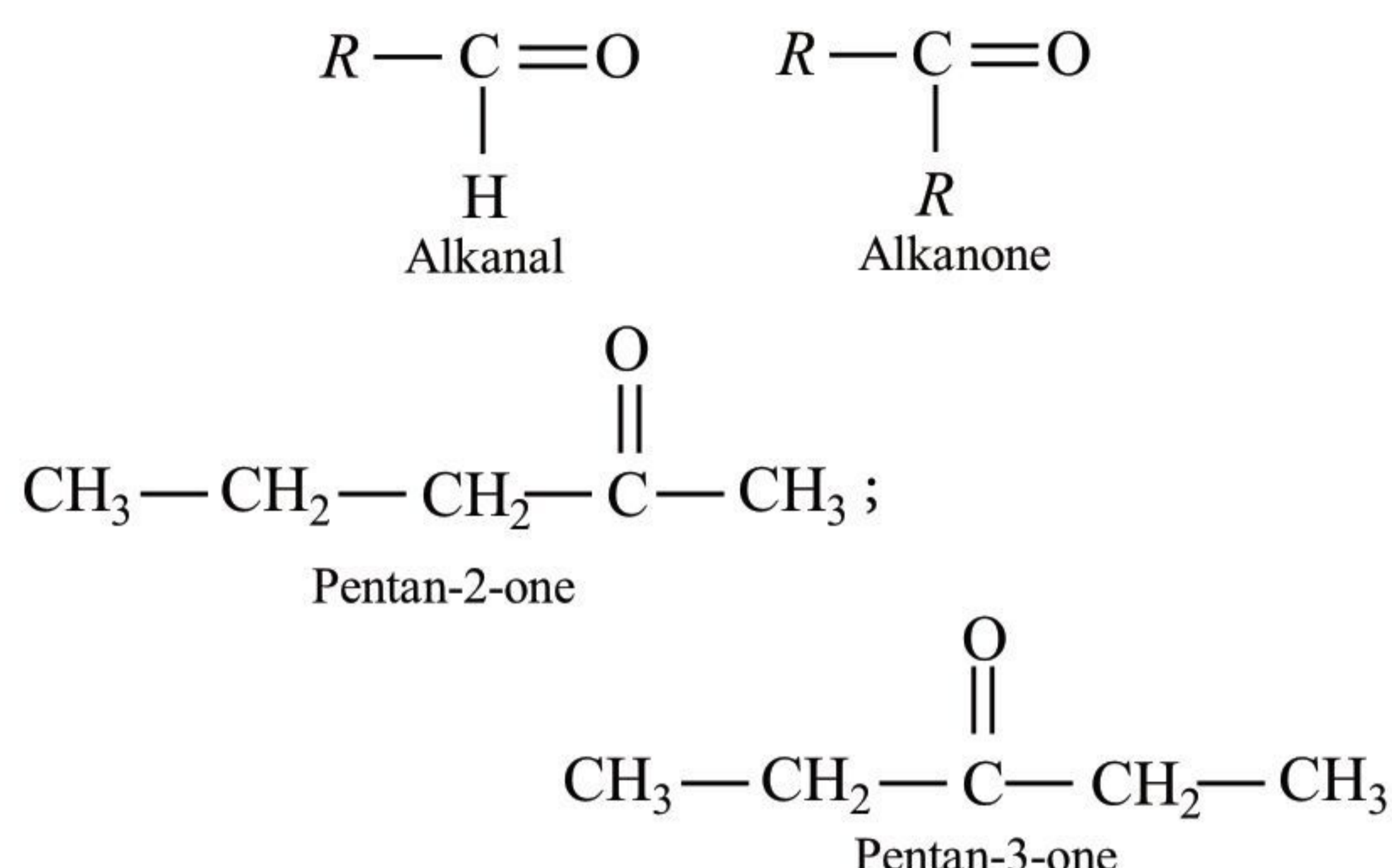
- Carbonyl group consists of one σ and one π bond like $>C=C<$. Here both carbon and oxygen are in sp^2 hybridized state. One of the sp^2 hybrid orbitals of C-atom forms σ bond by overlapping of one of sp^2 hybrid orbital of O-atom and π bond is formed by sidewise overlapping of unhybrid orbitals of both the atoms.



NOMENCLATURE

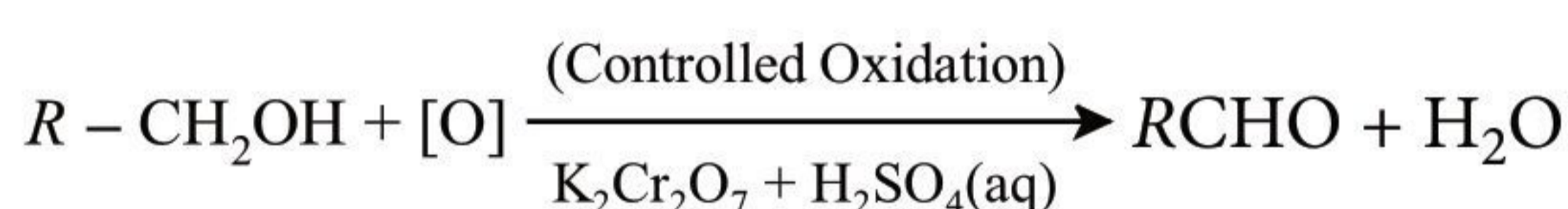
- According to IUPAC name 'e' of alkane is replaced by 'al' in case of aldehyde and 'e' of alkane is replaced by 'one' in case of ketone. Aldehyde is always at terminal, hence position of aldehydic group is

normally not indicated. In case of ketone we use position of carbonyl group whenever it is needed.

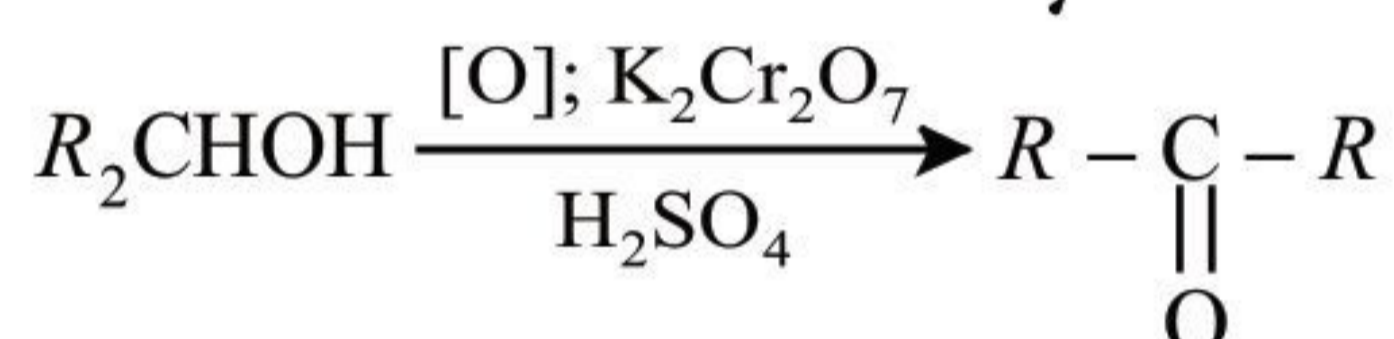


PREPARATION OF ALDEHYDES AND KETONES

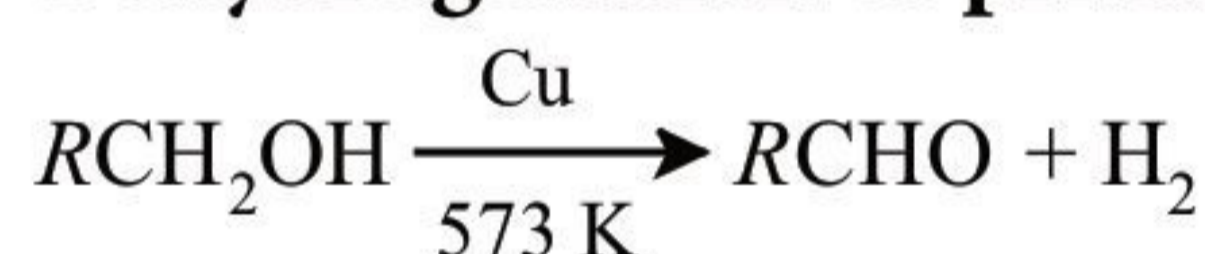
- Oxidation of primary alcohol**



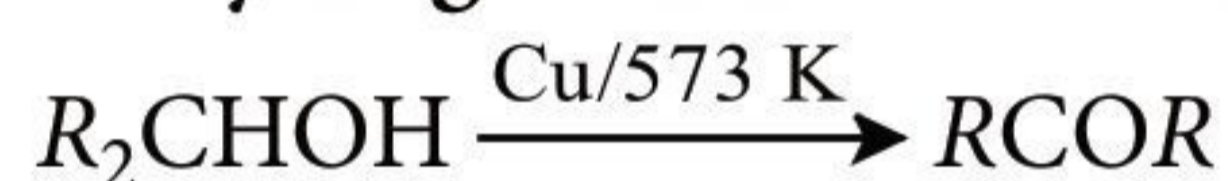
- Oxidation of secondary alcohols**



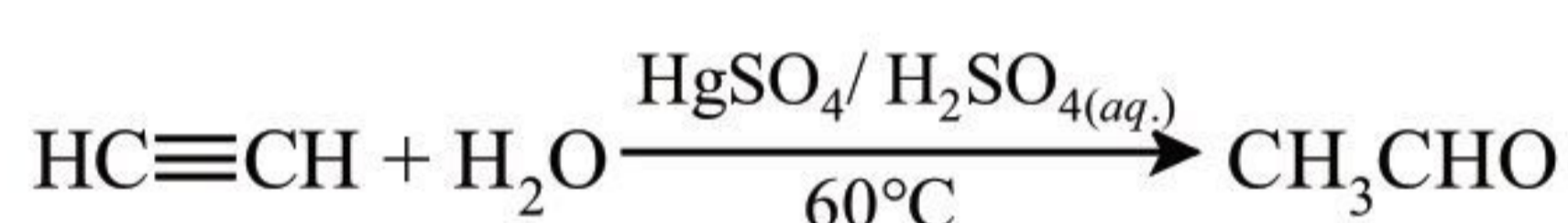
- Dehydrogenation of primary alcohol**



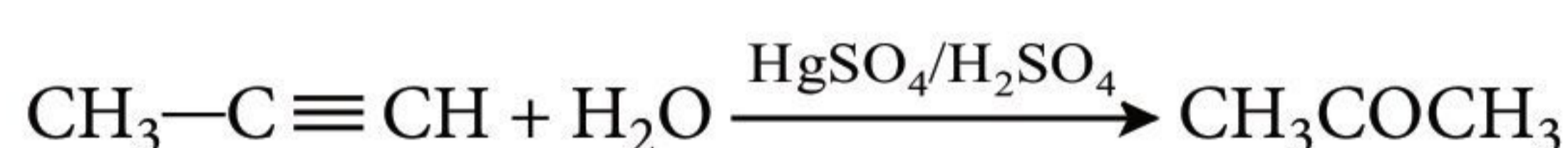
- Dehydrogenation of secondary alcohols**



- Hydration of Alkynes (Kucherov's reaction)**



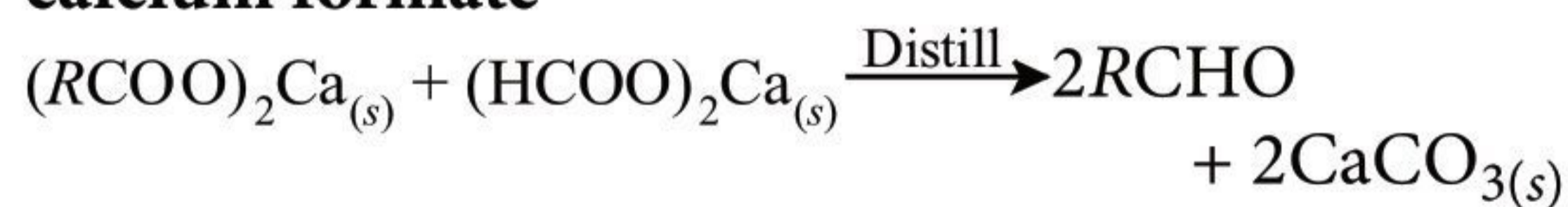
- Hydration of higher alkynes**



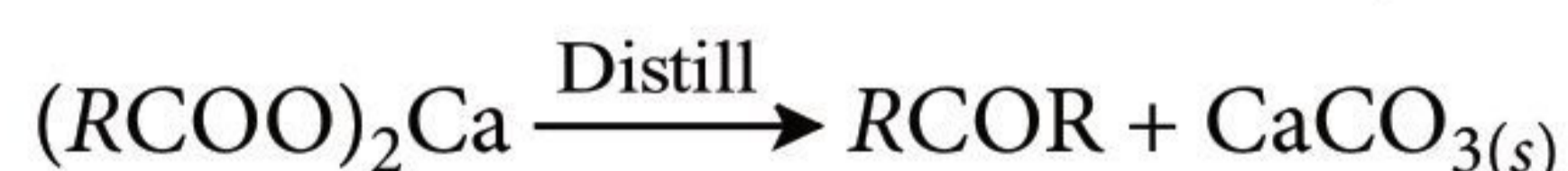
- When calcium formate is heated alone formaldehyde is obtained**



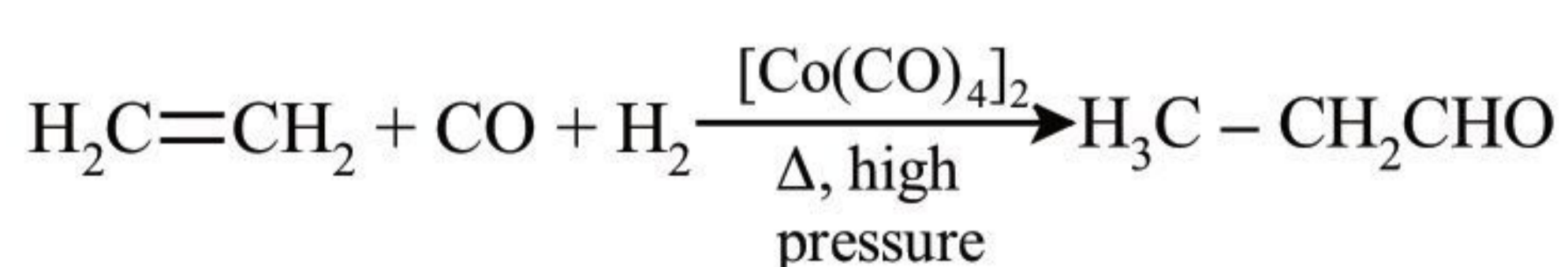
- Distillation of calcium salt of fatty acids with calcium formate**



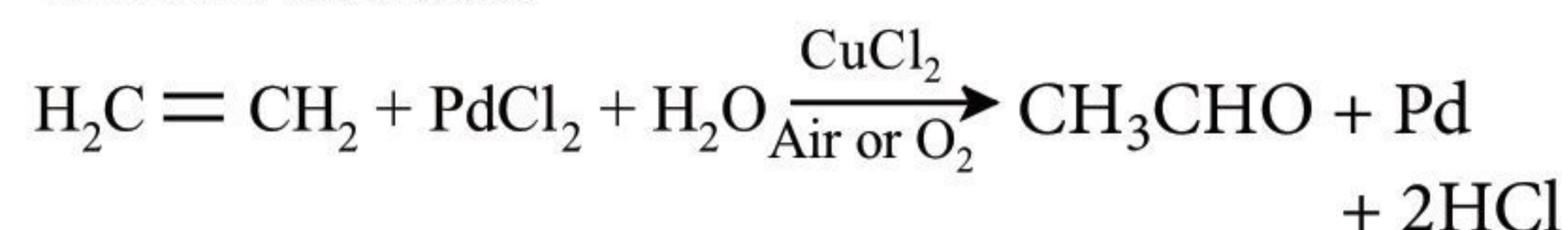
- Distillation of calcium salt of fatty acids**



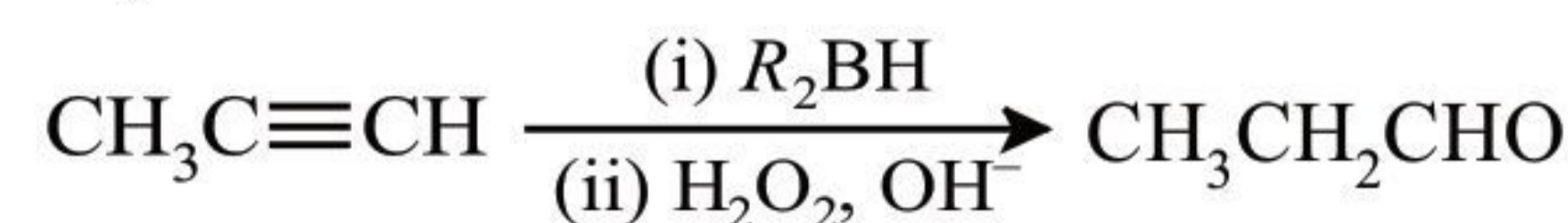
- Oxo process**



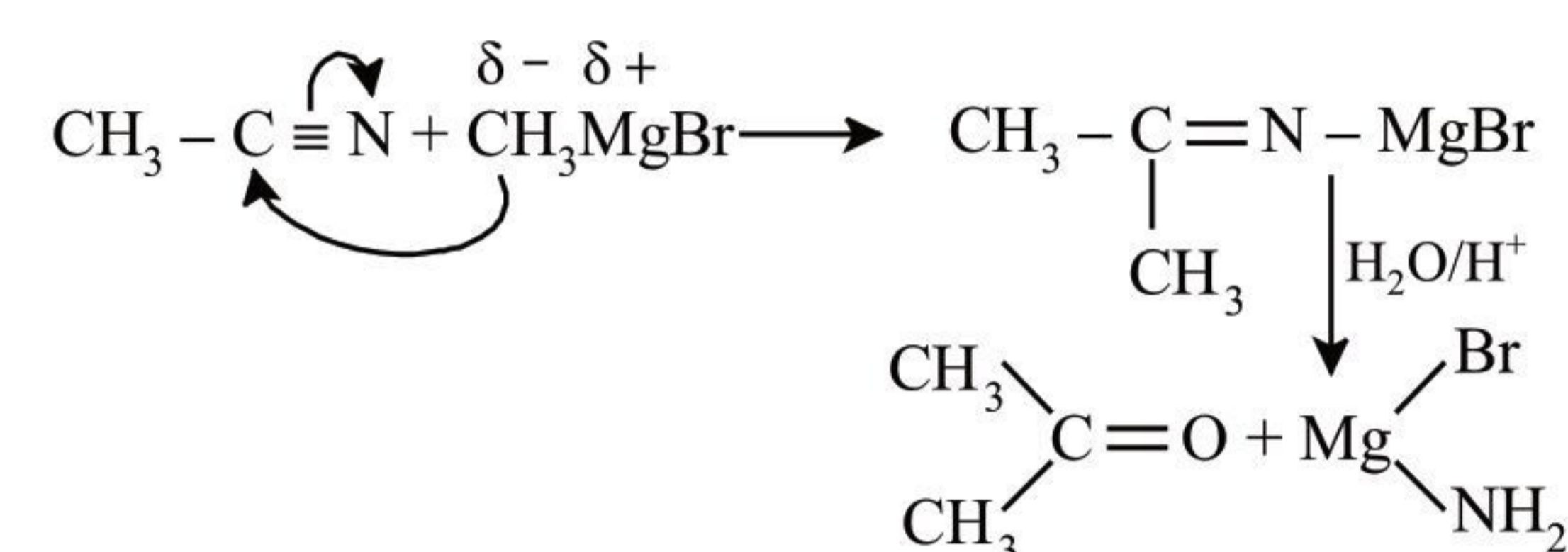
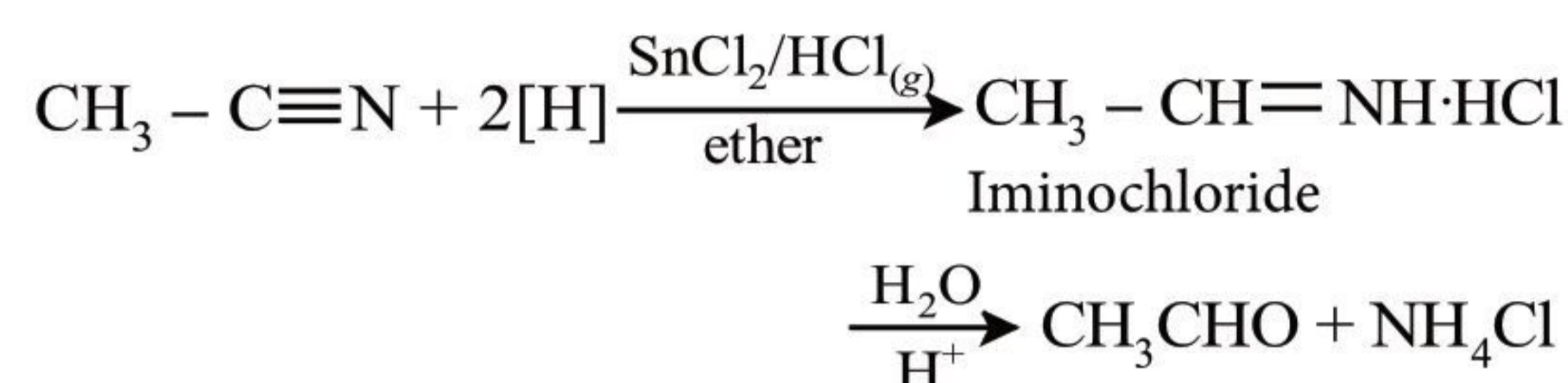
- Wacker method**



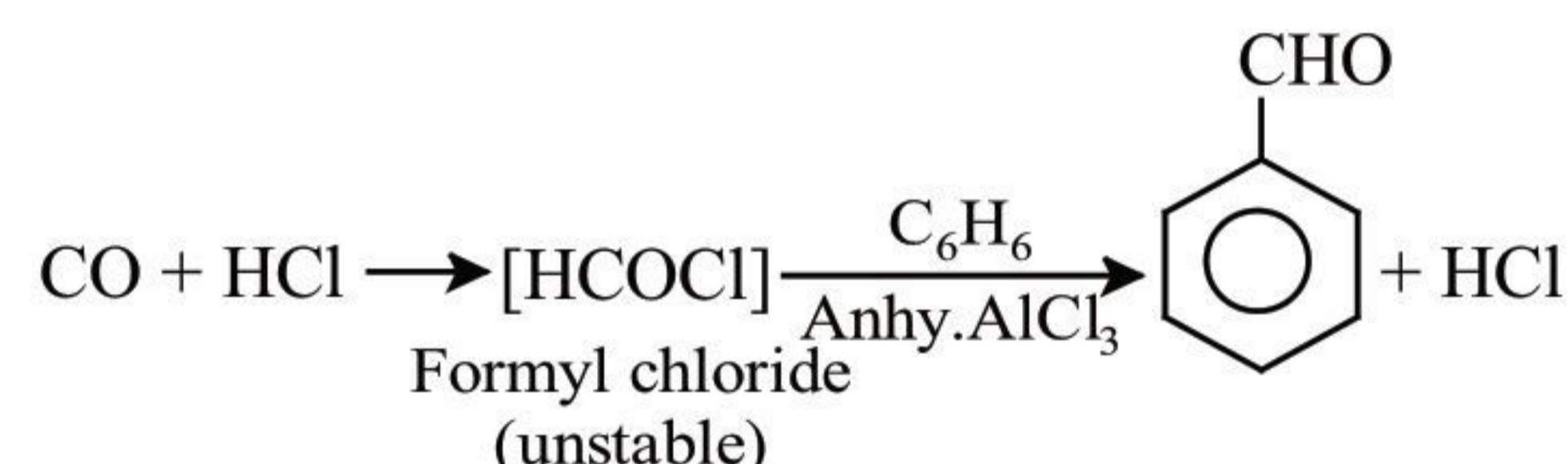
- Hydroboration – oxidation of terminal alkynes**



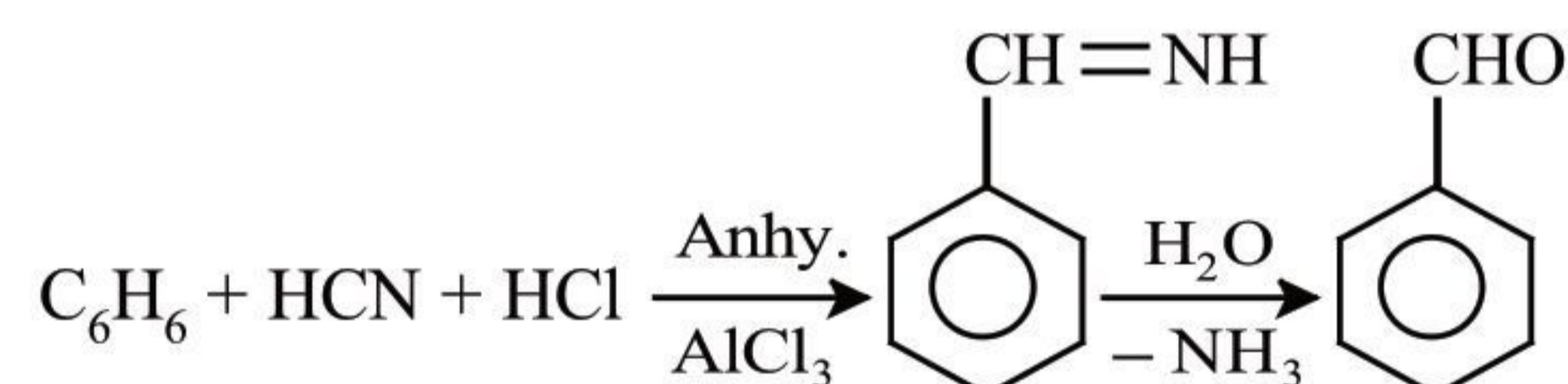
- From cyanides (Stephen's reduction)**



- Gattermann Koch Synthesis**



- Gattermann aldehyde synthesis**

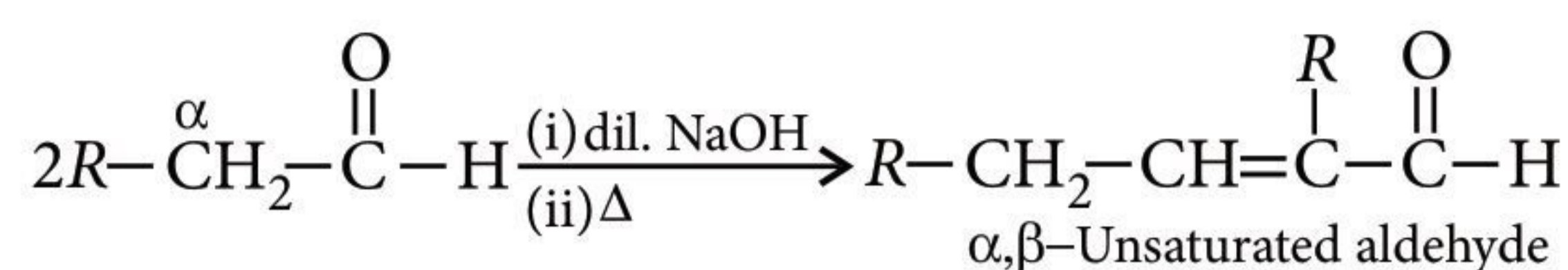


CHEMICAL REACTIONS

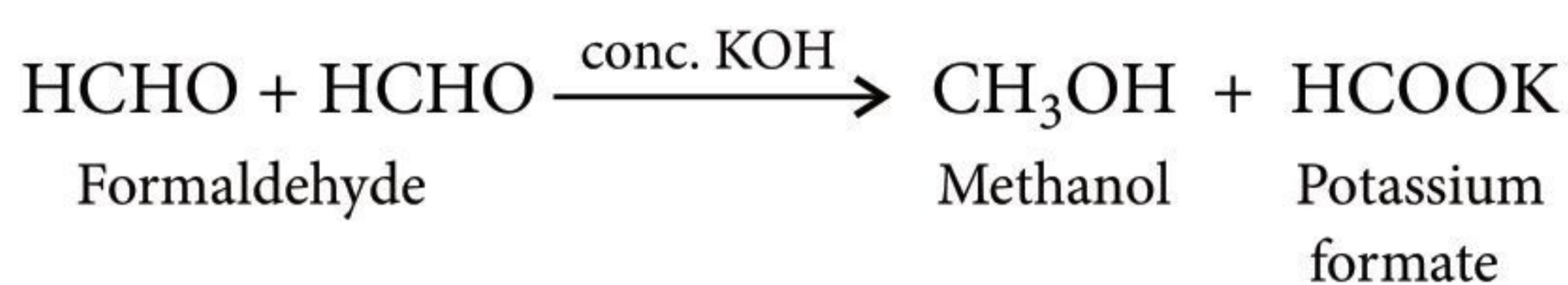
$RCOOH \xleftarrow{K_2Cr_2O_7/H^+}$	A L D E H Y D E S A N D K E T O N E S
$RCOO^- + 2Ag \downarrow \xleftarrow[\text{Silver mirror}]{2[Ag(NH_3)_2]^+OH^-, OH^-}$	
$RCOO^- + Cu_2O \downarrow \xleftarrow[\text{red ppt.}]{2Cu^{2+}, 5OH^-}$	
$RCOOR' \xleftarrow[\text{or } H_2SO_5]{C_6H_5CO_3H}$	
$RCOO^- + Cu_2O \xleftarrow[\text{red ppt.}]{CuO \text{ or } Cu(OH)_2}$	
$\begin{array}{c} R \\ \diagdown \\ R'-CHOH \end{array} \xleftarrow[\text{Pt or Pd}]{LiAlH_4 \text{ or } NaBH_4 \text{ or } H_2/Ni \text{ or}}$	
Meerwein-Ponndorf-Verley reduction	
$\begin{array}{c} R \\ \diagdown \\ R'-CH-OH \end{array} \xleftarrow{[(CH_3)_2CHO]_3Al + (CH_3)_2CHOH}$	

Clemmensen reduction	$\text{H}_2\text{O} + \begin{matrix} R \\ \diagup \\ \text{C} \\ \diagdown \\ R' \end{matrix} \text{CH}_2 \xleftarrow{\text{Zn-Hg/HCl}}$	A
	$\begin{matrix} R \\ \diagup \\ \text{C} \\ \diagdown \\ R' \end{matrix} \text{CH}_2 \xleftarrow{\text{HI/Red P, 423 K}}$	L
		D
Wolff-Kishner reduction	$\text{N}_2 + \begin{matrix} R \\ \diagup \\ \text{C} \\ \diagdown \\ R' \end{matrix} \text{CH}_2 \xleftarrow[\text{KOH, glycol}]{\text{NH}_2-\text{NH}_2}$	E
	$\begin{matrix} & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \end{matrix} \text{C}=\text{NH} \xleftarrow[\text{(ii) } \Delta]{\text{(i) NH}_3}$ imine	H
	$\begin{matrix} & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \end{matrix} \text{C}=\text{N}-\text{Z} \xleftarrow[\text{(ii) } \Delta]{\text{(i) NH}_2-\text{Z}}$ imine derivatives	Y
	$\left[\begin{matrix} \text{Z = Alkyl, Aryl, } -\text{OH, } -\text{NH}_2, -\text{NHC}_6\text{H}_5, \\ -\text{NH}-\text{C}_6\text{H}_4(\text{NO}_2)_2, -\text{NHCONH}_2 \end{matrix} \right]$	D
	$\text{RCH} \begin{matrix} \text{OH} \\ \diagup \\ \text{CN} \end{matrix} \xleftarrow[\text{CN}^-]{\text{HCN}}$	K
	$\left[\begin{matrix} & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \end{matrix} \text{C} \begin{matrix} R \\ \diagup \\ \text{OMg}^+ \end{matrix} \right] \xleftarrow{\text{RMgX}}$	E
	$\begin{matrix} & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \end{matrix} \text{C} \begin{matrix} R \\ \diagup \\ \text{OH} \end{matrix} + \text{Mg} \begin{matrix} \text{OH} \\ \diagup \\ \text{X} \end{matrix} \xleftarrow{\text{HOH, H}^+}$	T
		O
		N
		E
		S

Aldol condensation

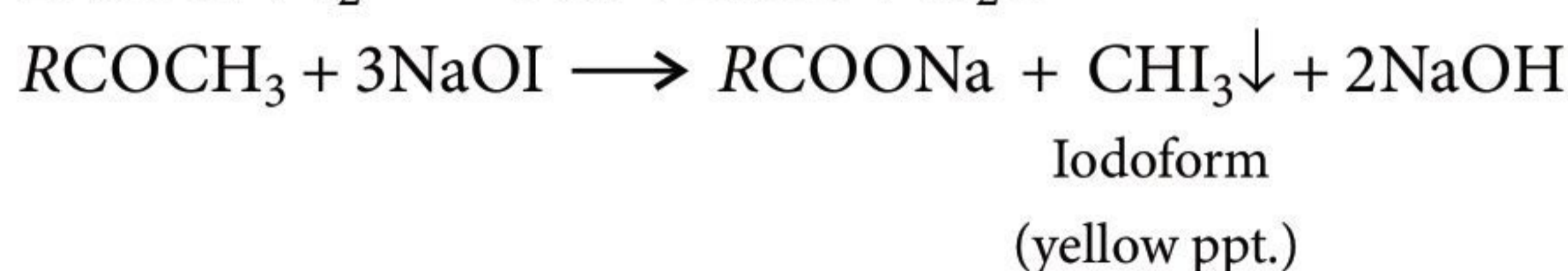


Cannizzaro reaction



Haloform reaction

Given by methyl ketones (even acetaldehyde).

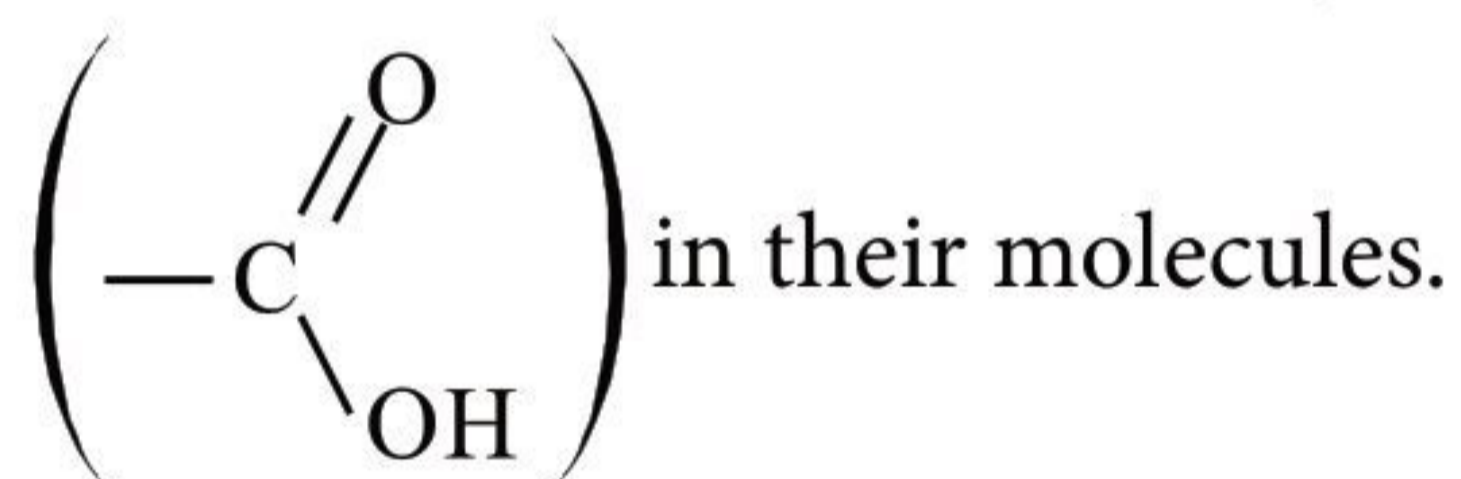


COMPARISON BETWEEN ALDEHYDES AND KETONES

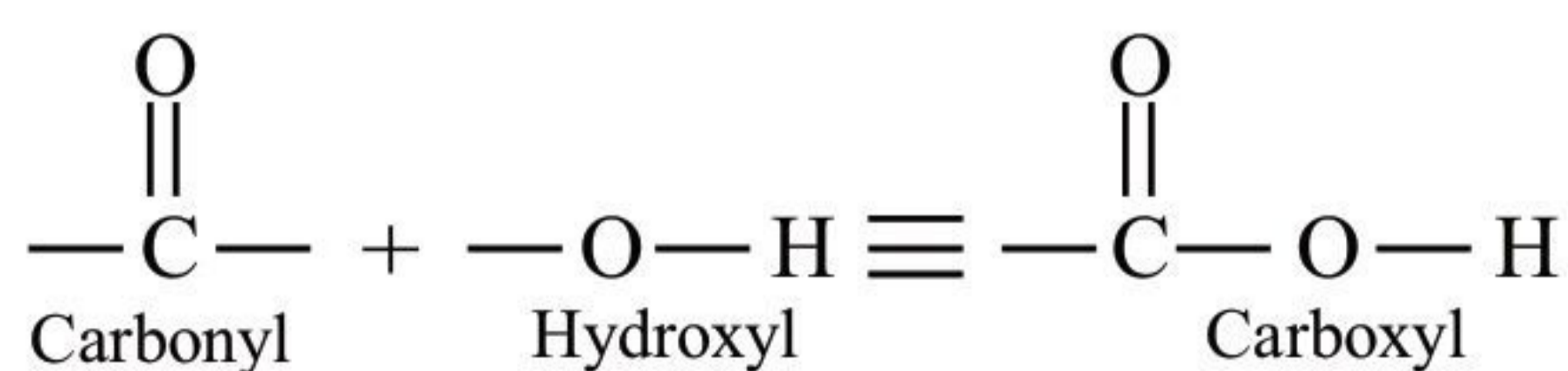
S.No.	Test	RCHO	RCOR
1.	Schiff's reagent	Pink colour is given by RCHO	No reaction
2.	Tollen's reagent	Silver deposit	No reaction
3.	Fehling's solution	Red Precipitate	No reaction

Carboxylic Acids

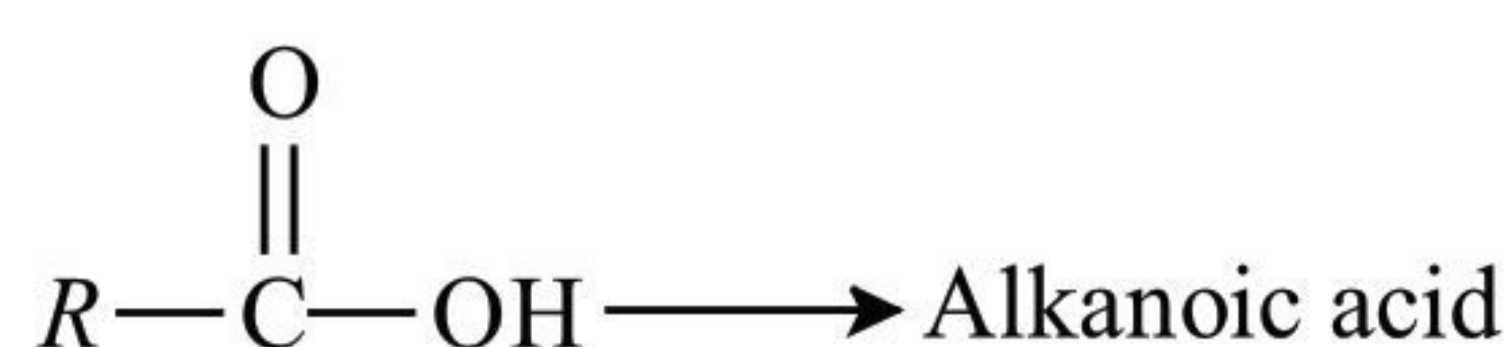
- Carboxylic acids are organic compounds which have one or more carboxyl functional group



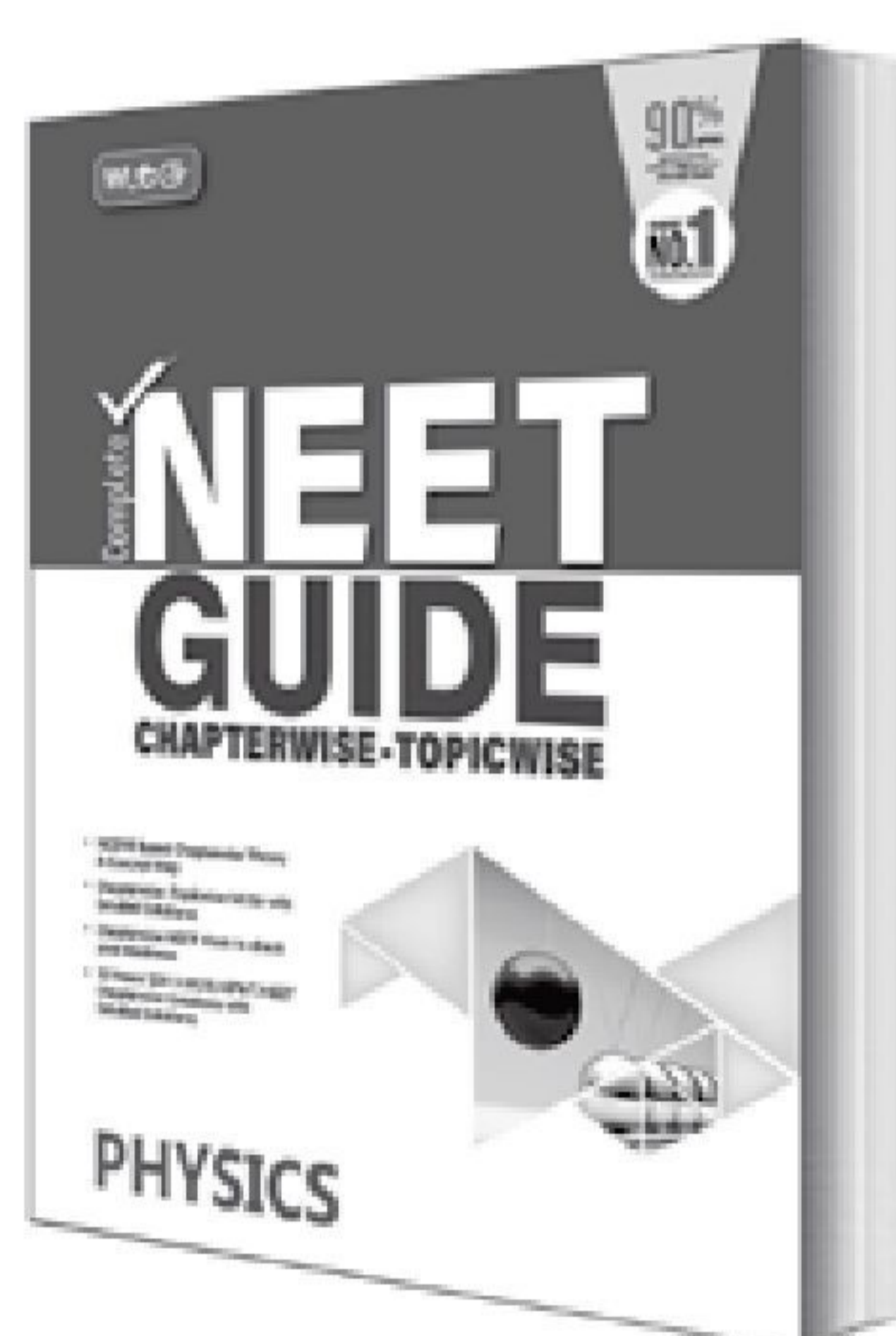
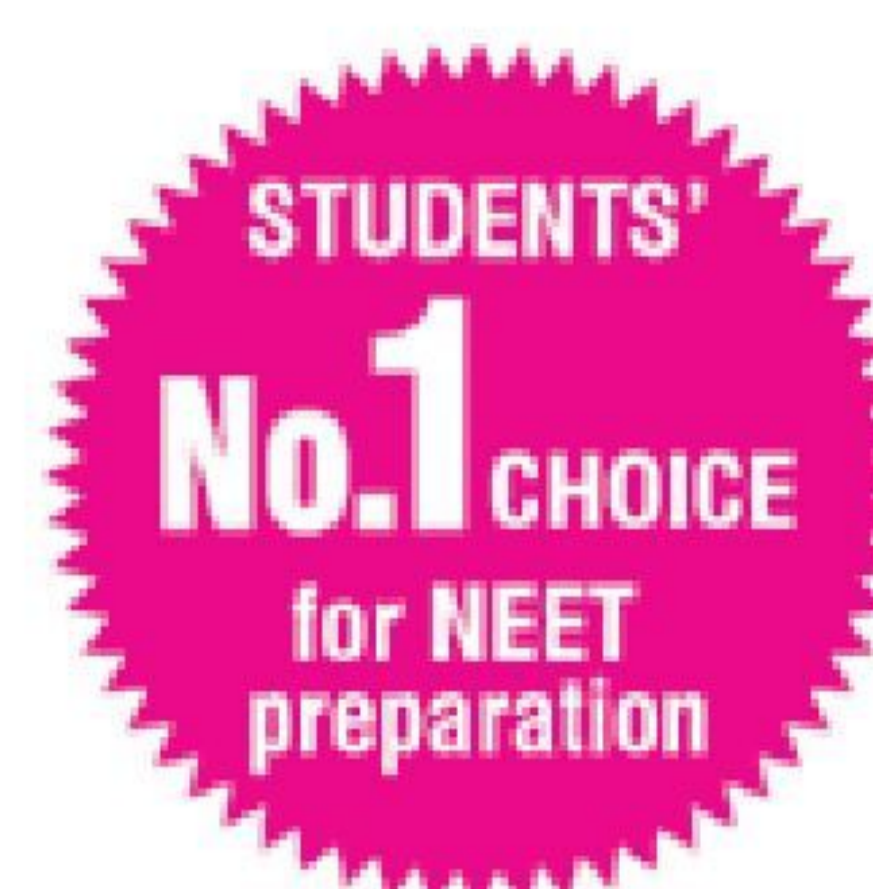
- The name carboxyl has been derived from carbo from the carbonyl group and oxyl from the hydroxyl group, because in the carboxyl group these two groups are directly bonded to each other. The properties of the carboxyl group are not simply those of carbonyl and hydroxyl groups combined; the two groups interact to give carboxylic acids their own distinctive properties, *i.e.*, the carboxyl group has its own properties.



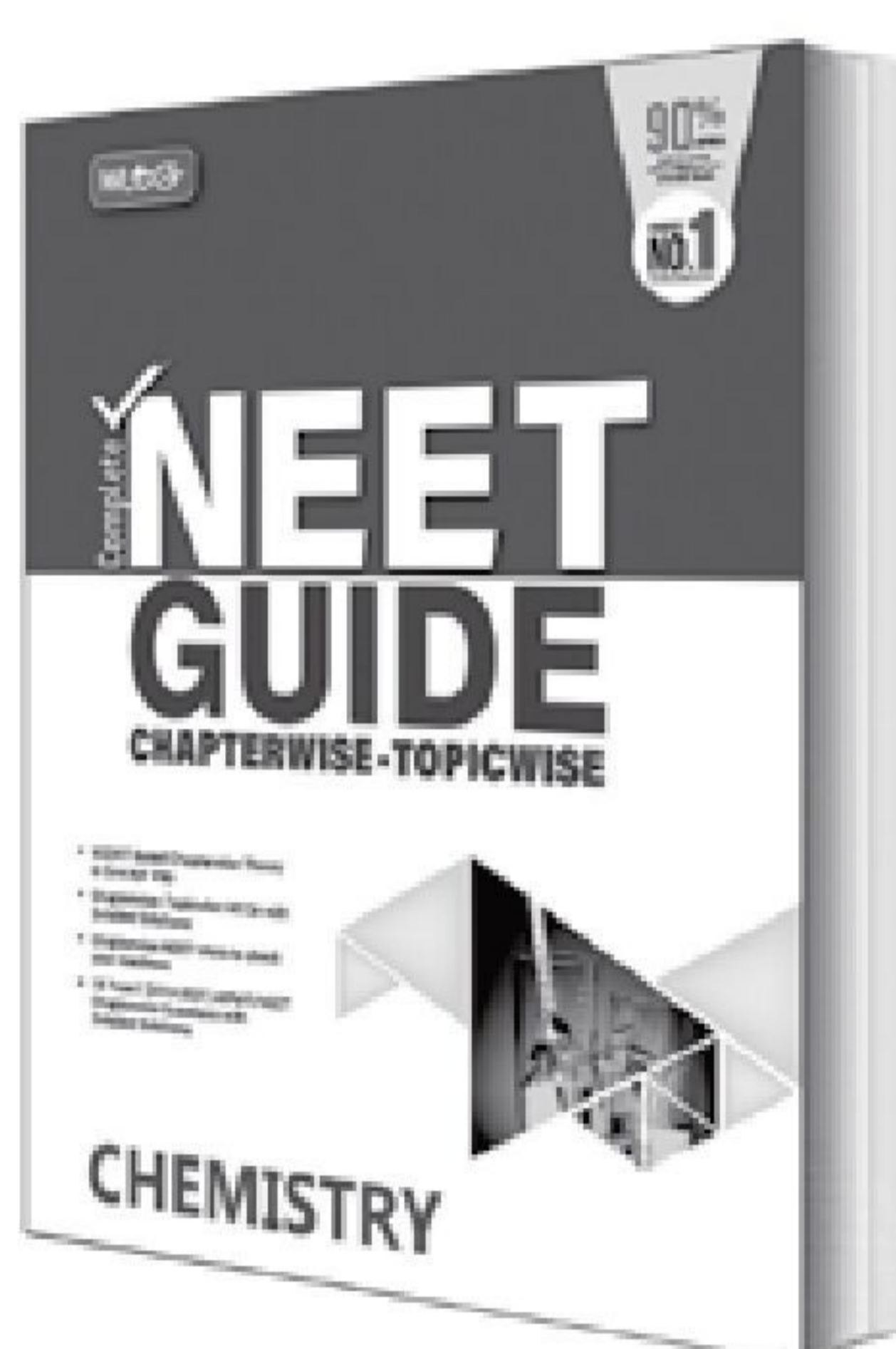
- The common or trivial names of carboxylic acids are based on their sources of origin. For example, formic acid (HCOOH) is so named because it was first obtained from red ants (Latin formica means ants). Similarly, acetic acid (CH₃COOH) is so named because it was obtained from vinegar (Latin acetum meaning vinegar), butyric acid (CH₃CH₂CH₂COOH) from rancid butter (Latin butyrum meaning butter), caproic acid (CH₃CH₂CH₂CH₂CH₂COOH) from goats (Latin caper meaning goat), etc.
- In common system, the position of the substituents is indicated by the Greek letters (α , β , γ , δ , etc).
- While writing IUPAC name of carboxylic acid 'e' of alkane is replaced by 'oic acid.' The carboxyl carbon is always given number 1 *i.e.*, it is always at terminal position.



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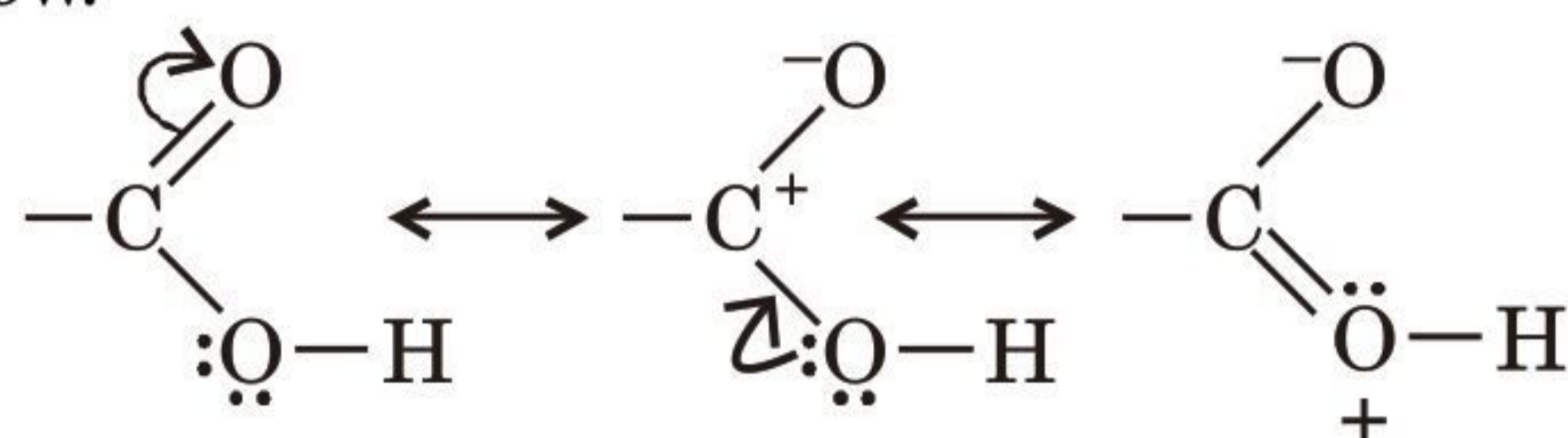
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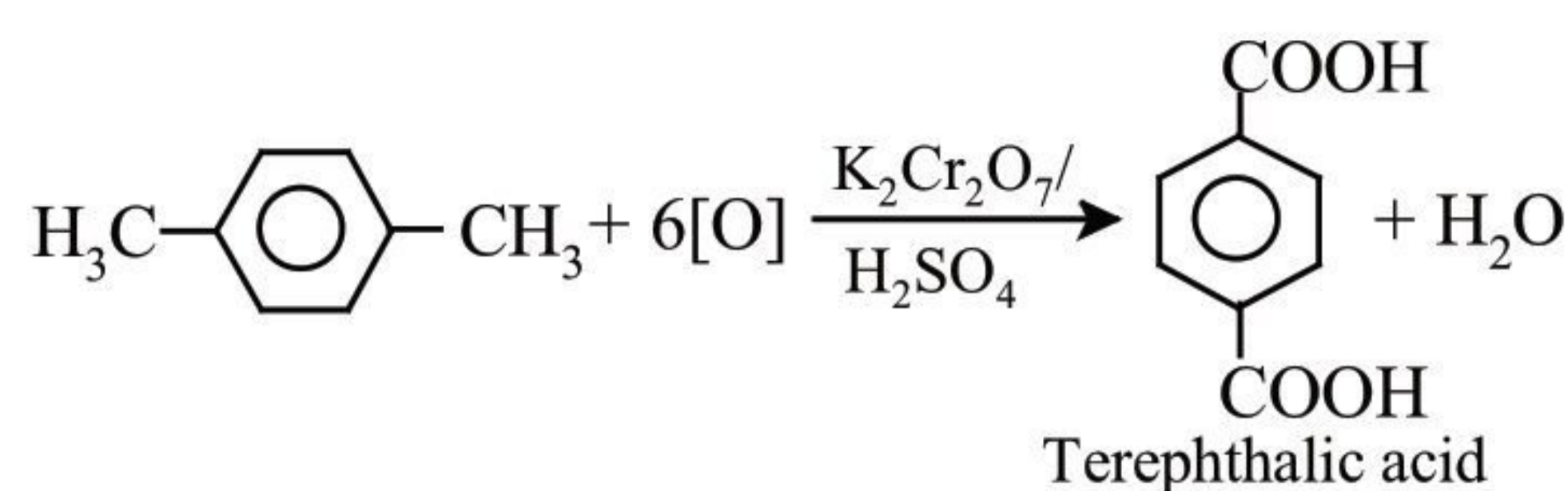
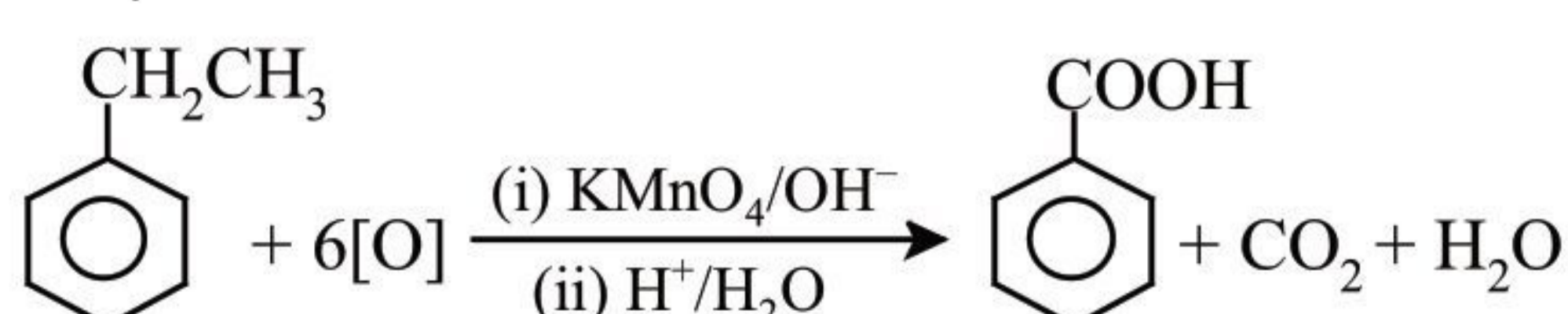
STRUCTURE

- In carboxylic group, carbon atom and the two oxygen atoms are sp^2 hybridized.
- The bonds to the carboxyl carbon lie in one plane and are separated by about 120° . The carboxylic carbon is less electrophilic than carbonyl carbon because of the possible resonance structure shown below.



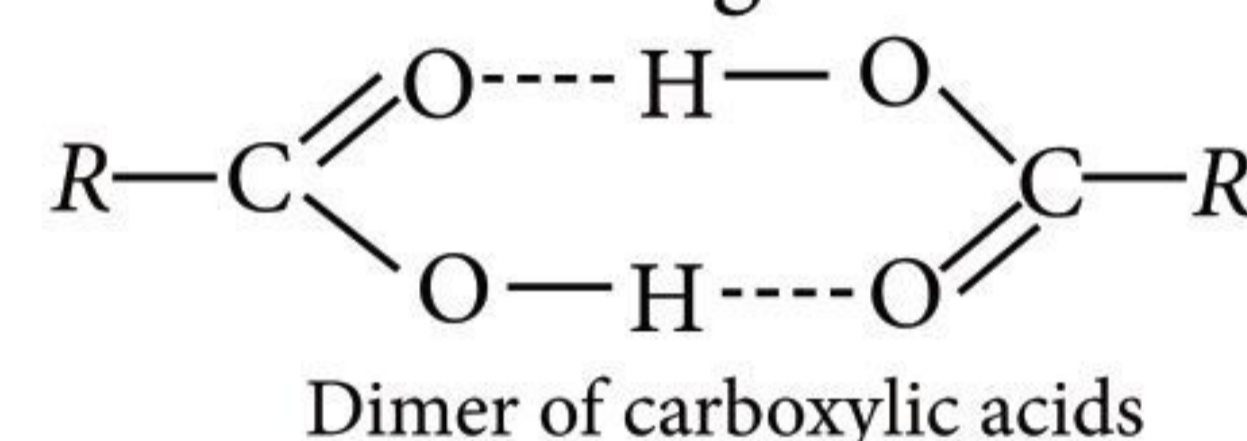
METHODS OF PREPARATION

- $RMgX \xrightarrow[(ii) H_2O/H^+]{(i) CO_2} RCOOH$ (Carbonation of Grignard reagent)
- $RCH_2OH \xrightarrow[[O]{K_2Cr_2O_7/H^+} RCOOH$ (oxidation of 1° alcohol)
- $RCOCl \xrightarrow{H_2O/H^+} RCOOH$ (Hydrolysis of acid chlorides)
- (i) $RCONH_2 \xrightarrow[\Delta]{H_2O/H^+} RCOOH + NH_4^+$ (Hydrolysis of amides)
(ii) $RCONH_2 + HNO_2 \longrightarrow RCOOH + N_2 + H_2O$
- $R-C \equiv N \xrightarrow{2H_2O/H^+} RCOOH + NH_4^+$ (Hydrolysis of alkyl cyanides)
- Koch Reaction:** $H_2C=CH_2 + CO + H_2O \xrightarrow[673\text{ K}]{H_3PO_4} H_3C-CH_2-COOH$ (steam) high pressure
- Halo form Reaction :**
 $CH_3-C(=O)-R \xrightarrow{NaOI} CHI_3 + RCOONa$
 $CH_3CHOH-R \xrightarrow{NaOI} CHI_3 + RCOONa$
- Thermal Decomposition of α -Dioic Acids:**
 $\begin{array}{c} COOH \\ | \\ COOH \end{array} \xrightarrow{\Delta} HCOOH + CO_2$
 $CH_2(COOH)_2 \xrightarrow{\Delta} CH_3COOH + CO_2$ (Malonic acid)
- Hydrolysis of 1, 1, 1-trihalo Derivative:**
 $R-CCl_3 + 4KOH \longrightarrow RCOOK + 3KCl + H_2O$
- Aromatic acids are obtained by the oxidation of alkyl benzenes.



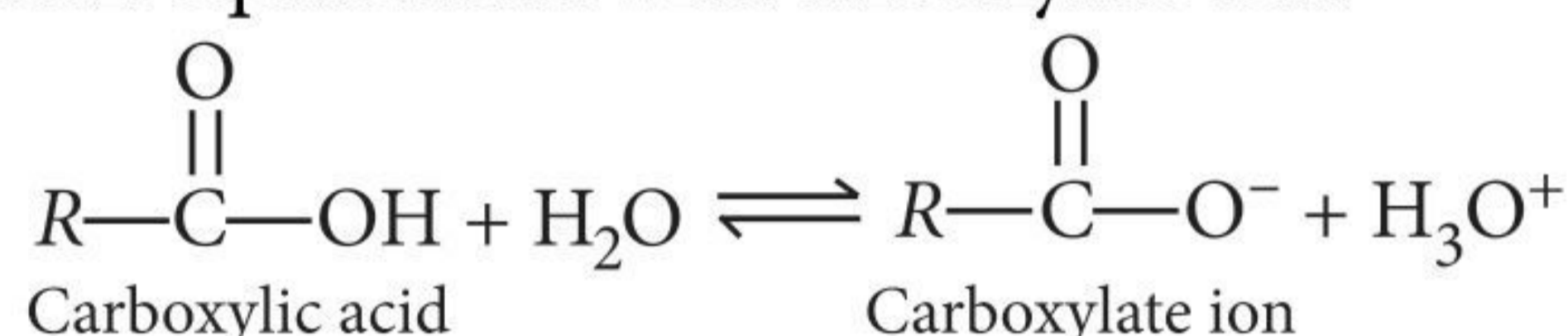
PHYSICAL PROPERTIES OF CARBOXYLIC ACIDS

- Lower members are colourless, liquids with characteristic odour. But higher members (above C_{10}) are colourless and odourless waxy solids due to low volatility. Aromatic acids are colourless, odourless solids.
- Lower aliphatic carboxylic acids ($C_1 - C_4$) are soluble in water due to H-bonding. Solubility decreases with increased molecular weight and $C_6H_{13}COOH$ is fairly insoluble in water. Aromatic acids are nearly insoluble in water due to large hydrocarbon part.
- Carboxylic acids are polar in nature and exist as dimer in vapour state or in aprotic solvents due to the formation of H-bonding.

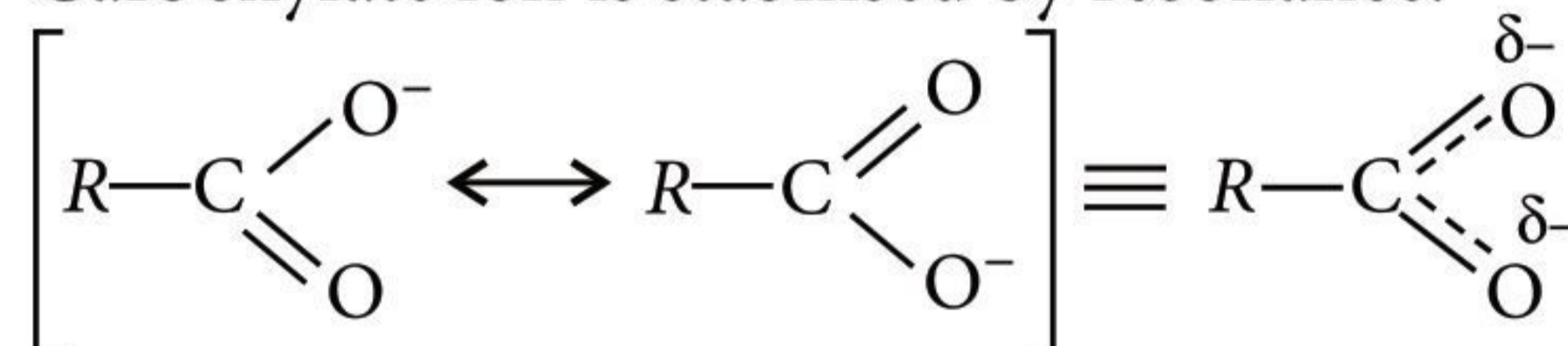


ACIDIC STRENGTH OF CARBOXYLIC ACIDS

- Carboxylic acids ionize in aqueous solution and exist in equilibrium with carboxylate ion.



- Carboxylate ion is stabilised by resonance.



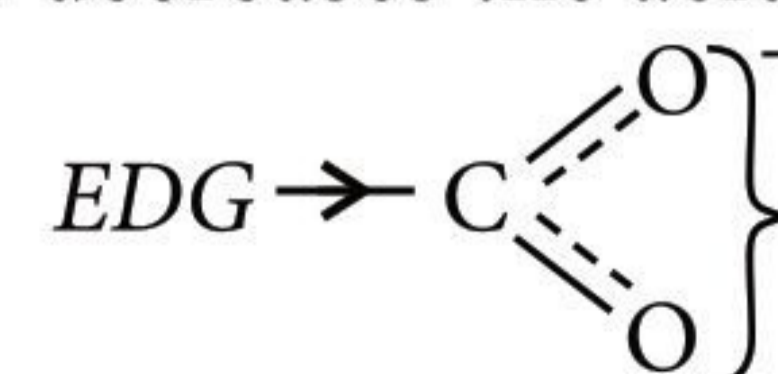
Thus, equilibrium shifts towards more stable carboxylate ion. Strength of acids can also be expressed in terms of pK_a value.

$$pK_a = -\log K_a$$

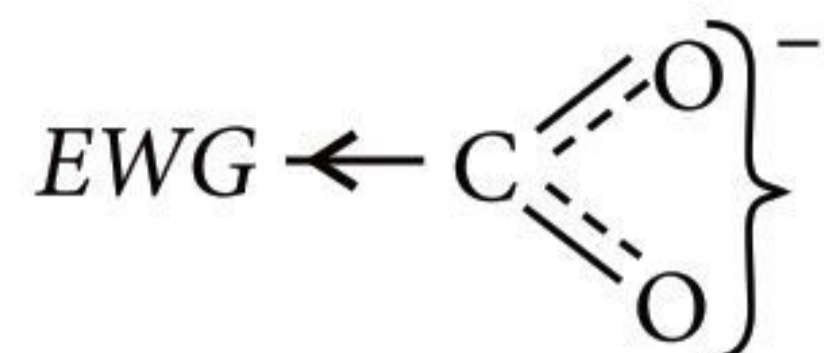
Greater the K_a value, smaller will be pK_a value and hence stronger is the carboxylic acid.

Effect of Substituent on Acidic Strength of Carboxylic Acids

- Electron donating group (+I effect)**, destabilises the carboxylate ion by intensifying the negative charge and thus decreases the acidic strength.



- **Electron withdrawing group** ($-I$ effect), stabilises the carboxylate ion by dispersing the negative charge on carboxylate ion and hence increases the acidic strength.

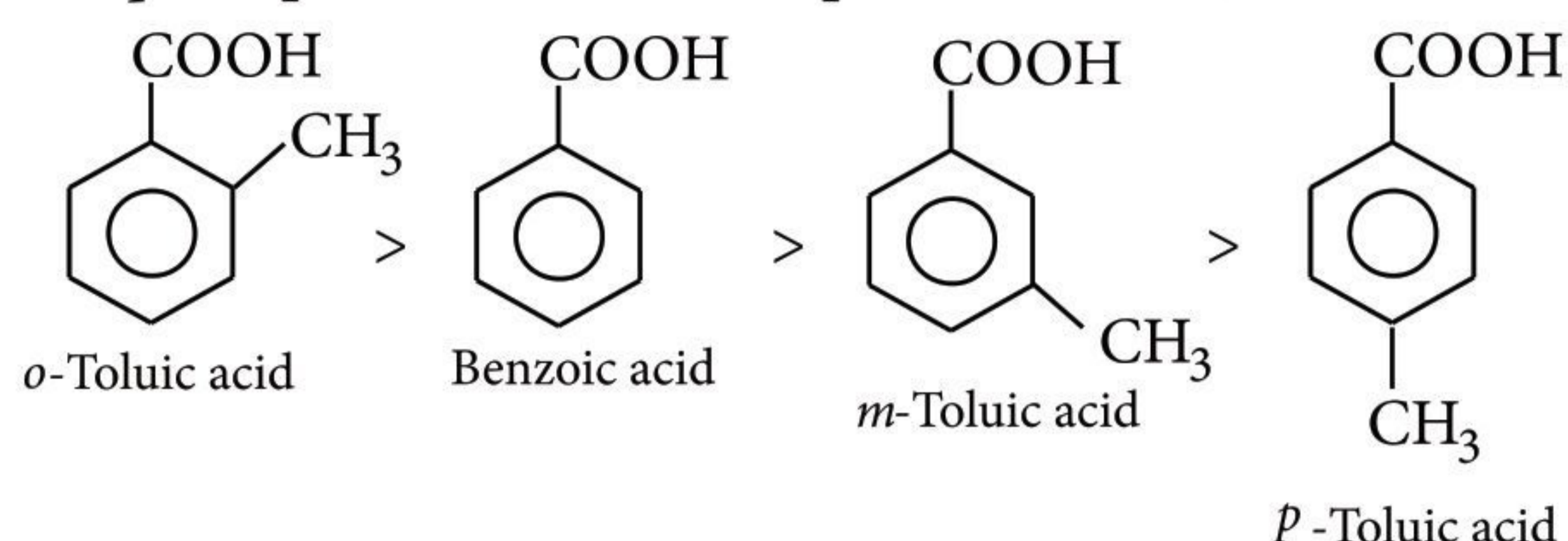


Relative Acidic Strength of Substituted Aromatic Acids

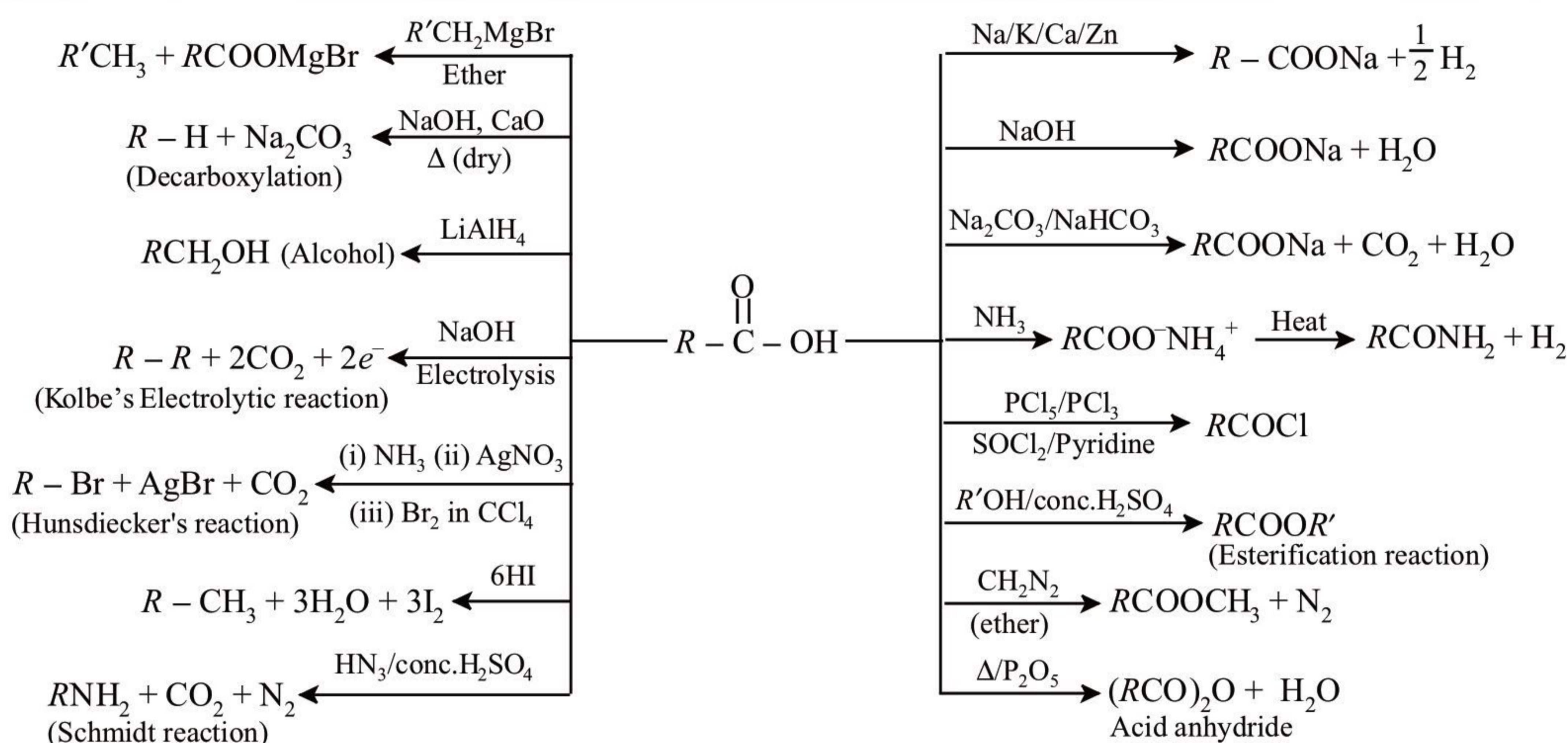
- Electron donating substituents ($+I$ effect) decrease the acidic strength whereas electron withdrawing

groups ($-I$ effect) increase the acidic strength of substituted benzoic acids.

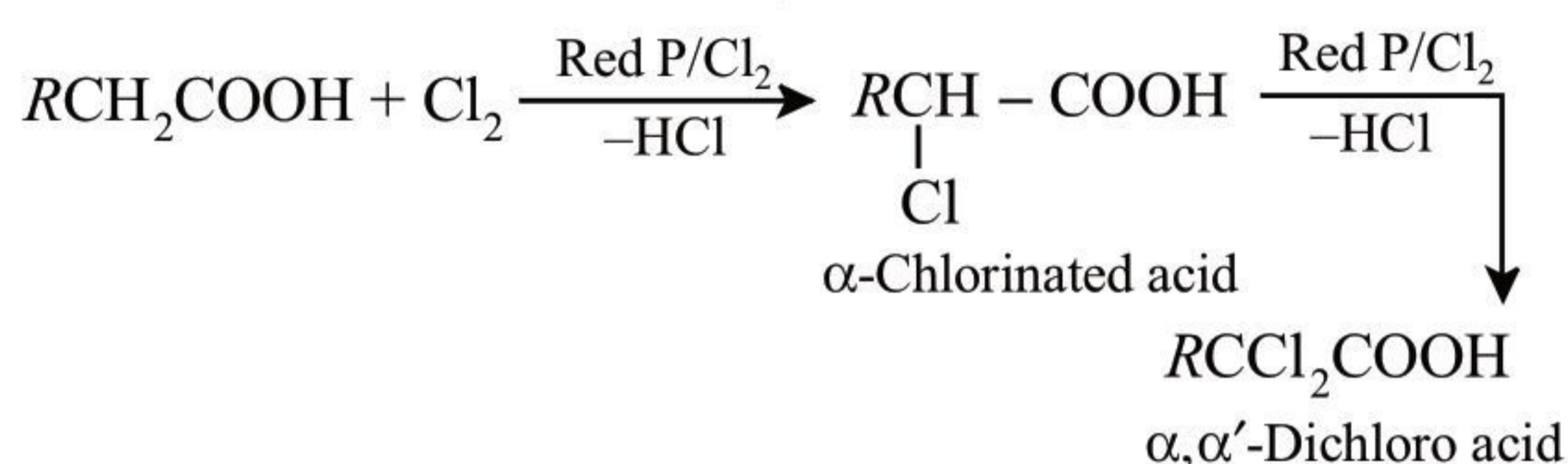
- *Ortho* substituted acids are stronger than benzoic acid irrespective of the nature of the substituent.
- Effect of any substituent is more pronounced at *para*-position than *meta*-position. Thus,



CHEMICAL PROPERTIES

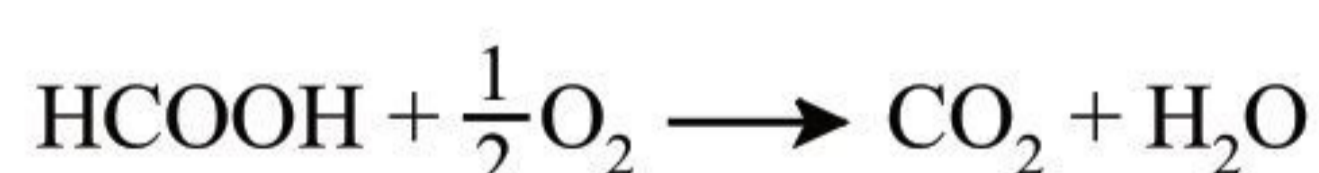


Hell—Volhard—Zelinsky (HVZ) Reaction

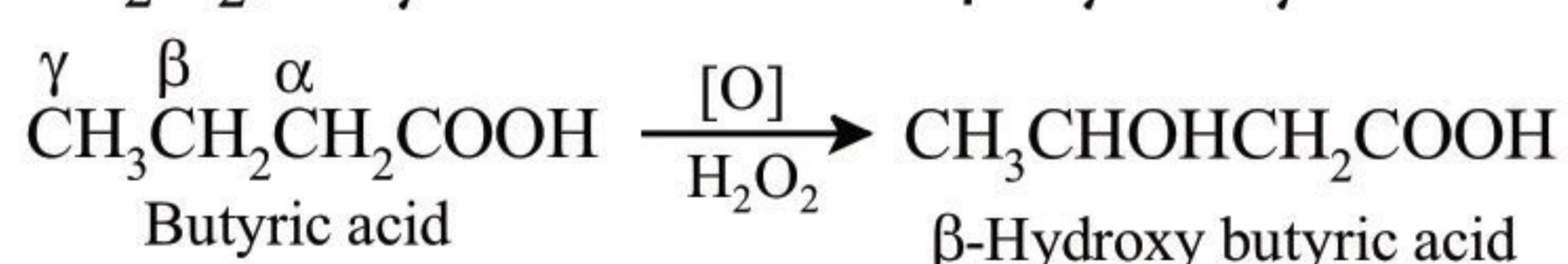


Oxidation

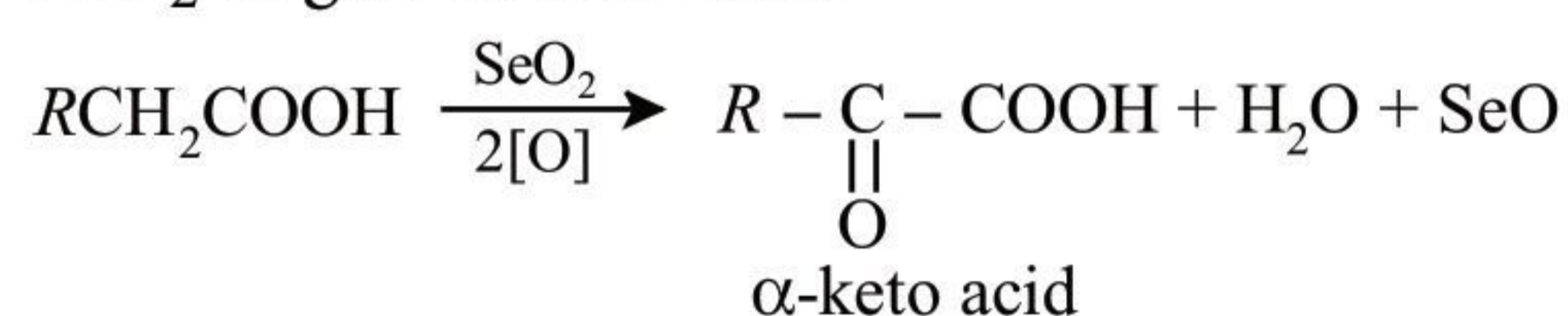
- Monocarboxylic acids except formic acid are extremely resistant to oxidation.



- Prolonged heating with powerful oxidising agents oxidises acids into carbon dioxide and water. With 3% H_2O_2 , they are oxidised to β -hydroxy acids.



Oxidation of α -methylene group takes place by SeO_2 to give α -keto acid.



- **Distinction between phenol and carboxylic acid :**

Test	Phenol	Carboxylic acid
$NaHCO_3$	No reaction	Brisk effervescence of CO_2 gas
$FeCl_3$ test	Violet colour	Buff coloured ppt.

- **Distinction between aliphatic and aromatic carboxylic acids : Sodium hydroxide test :** Dissolve a pinch of the organic acid in 2-3 ml of aq. $NaOH$ solution and shake well. Now acidify the above solution with dil. HCl . If a white or coloured ppt. is obtained, it indicates that the given organic compound is an aromatic acid otherwise it should be aliphatic.

Organic Compounds Containing Nitrogen

AMINES

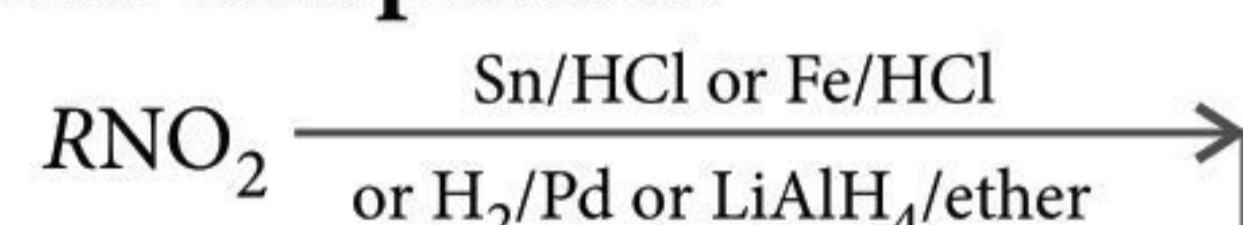
- The derivatives of ammonia formed by the replacement of one or more hydrogen atoms by the corresponding number of alkyl or aryl groups are known as *amines*. Like ammonia, nitrogen is sp^3 -hybridised and the geometry is pyramidal in amines.

Structure of Amino Group

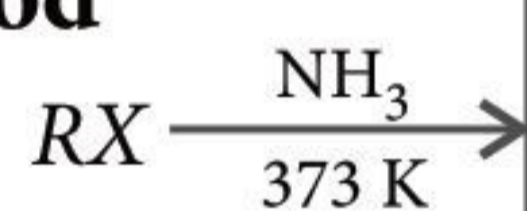
Nitrogen atom of amino group is sp^3 hybridised. Three of these orbitals get involved in sigma bond formation with other atoms whereas fourth orbital contains lone pair of electrons. Thus, amines are pyramidal in shape.

Preparation of Amines

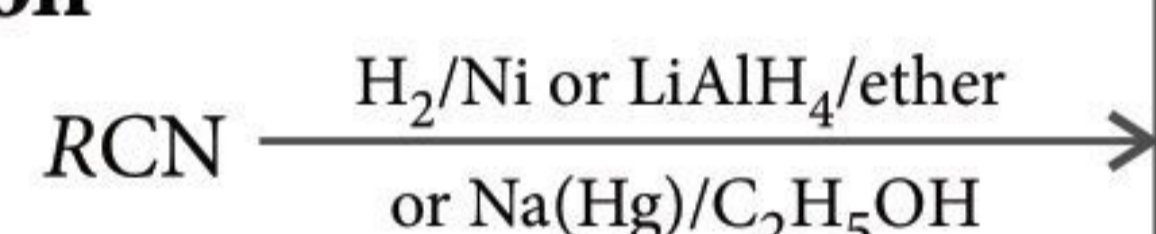
Reduction of nitro compounds



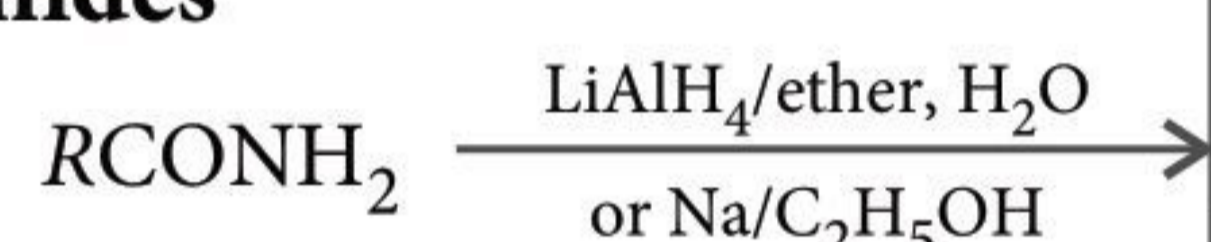
Hofmann's ammonolysis method



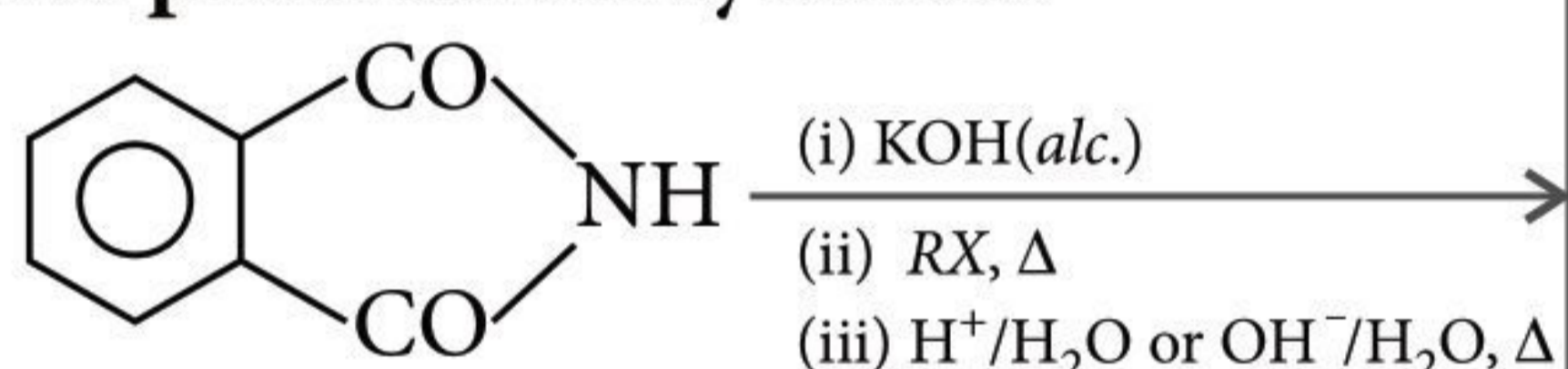
Mendius reduction



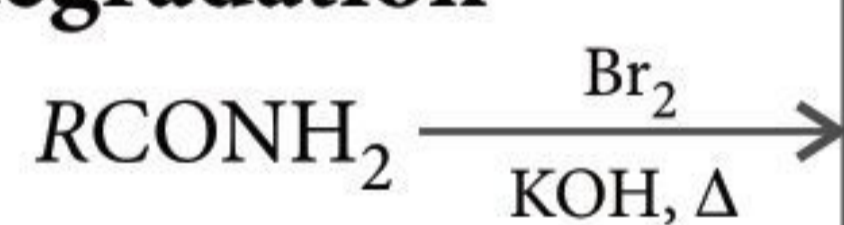
Reduction of amides



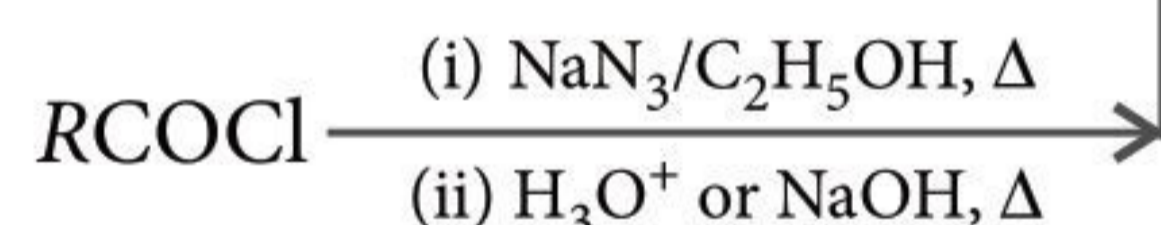
Gabriel phthalimide synthesis



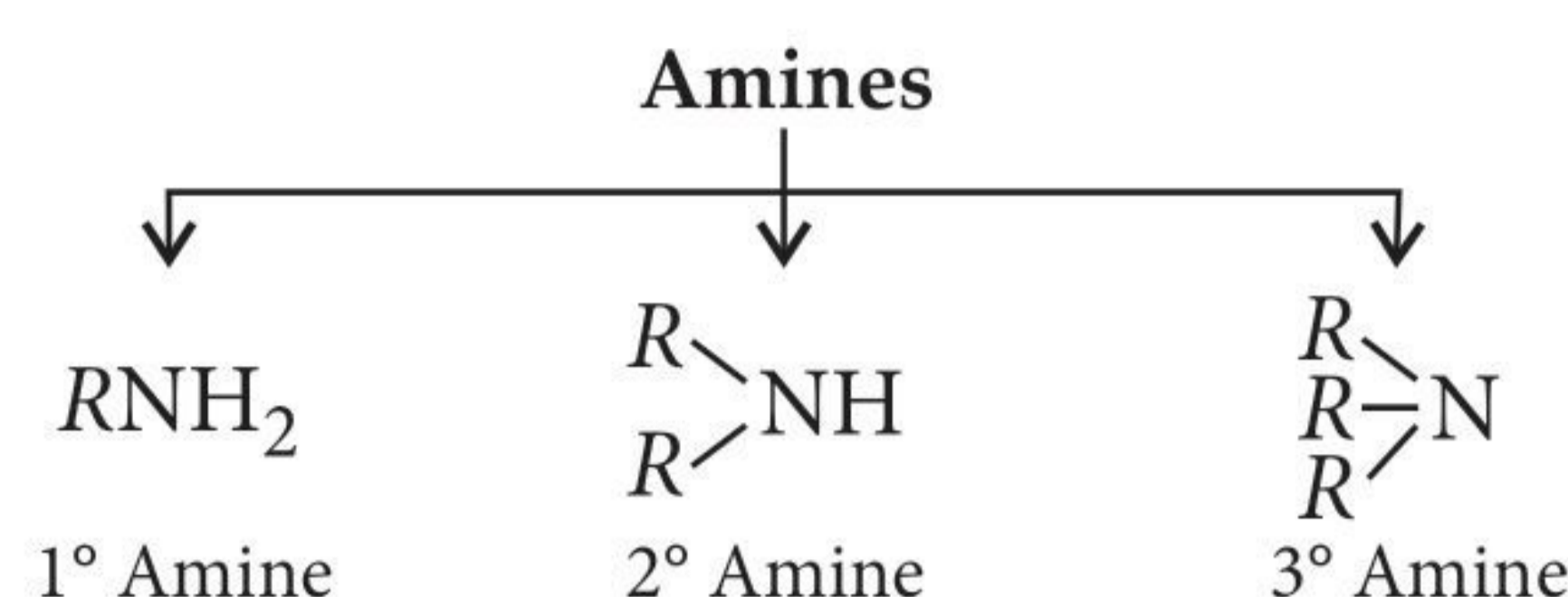
Hofmann bromamide degradation



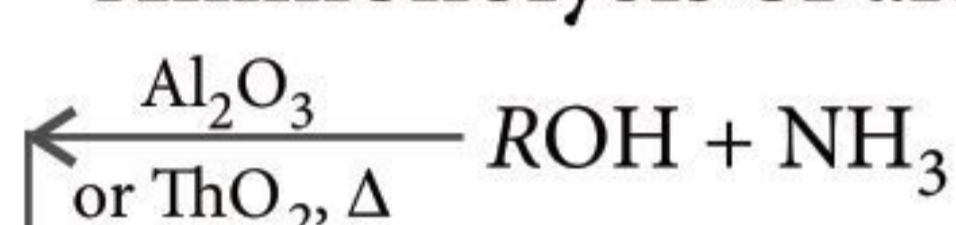
Curtius reaction



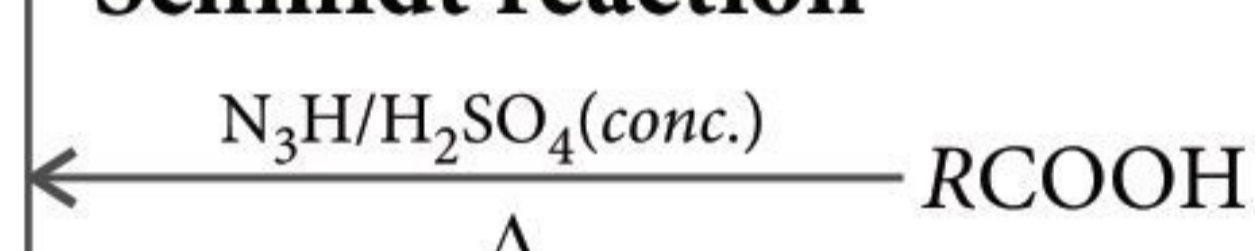
Classification



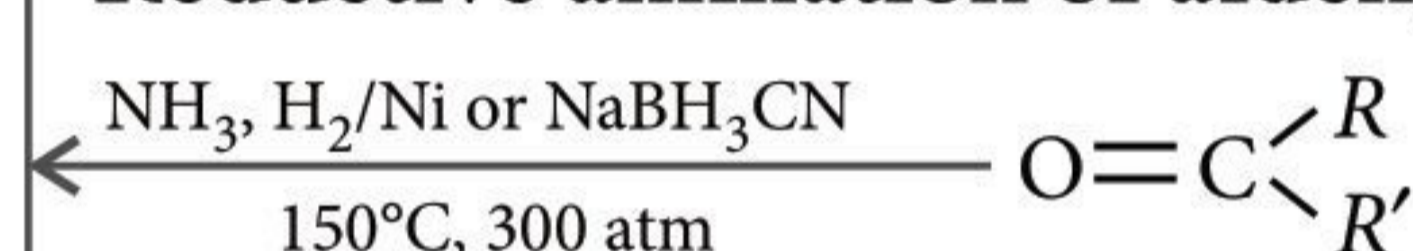
Ammonolysis of alcohols



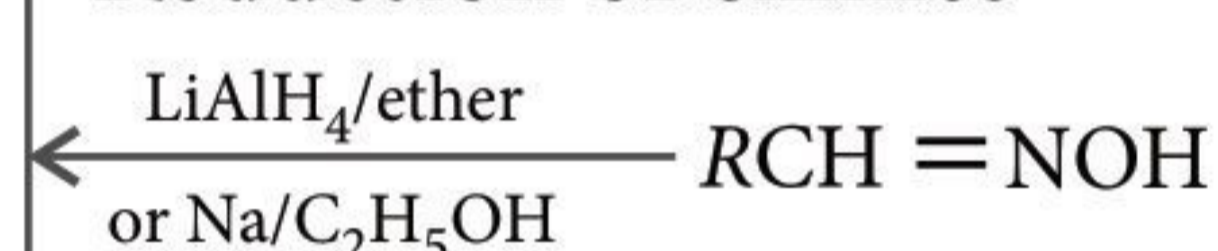
Schmidt reaction



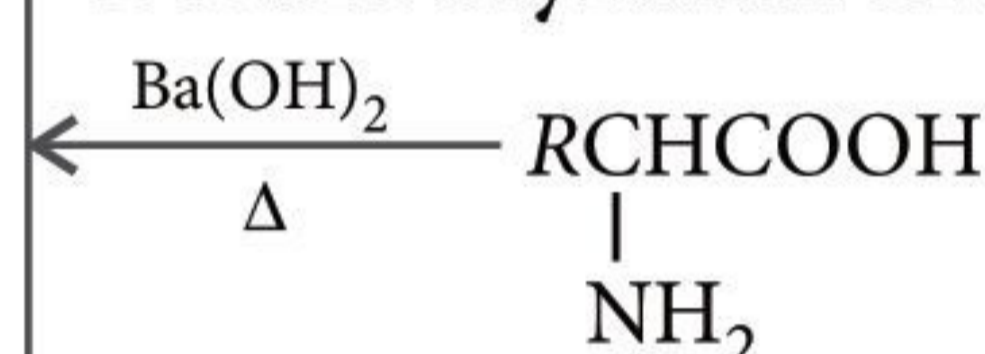
Reductive amination of aldehydes or ketones



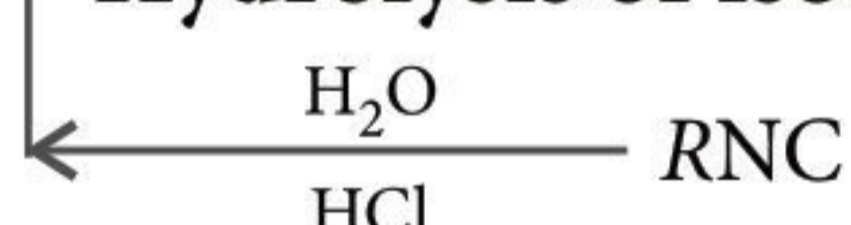
Reduction of oximes



Decarboxylation of α-amino acids



Hydrolysis of isocyanates



Physical Properties of Amines

- Lower members are gases, higher amines (C₄ to C₁₁) are volatile liquids while still higher members are solids. Lower members have fishy ammoniacal odour.
- Pure amines are almost colourless but develop colour on keeping in air for long time because of oxidation.
- Lower members are soluble in water, but solubility decreases with increase in molecular weight. Aromatic amines are insoluble in water. Both aliphatic and aromatic amines are fairly soluble in organic solvents.

- Amines have higher boiling points than hydrocarbons of comparable molecular masses because of intermolecular hydrogen bonding, but have lower boiling points than alcohols or carboxylic acids since intermolecular H-bonding in amines is not as strong as in case of alcohols or acids.

Basic Character of Amines

Nitrogen atom of amines has a lone pair of electrons, thus, amines behave as Lewis bases. Amines have a tendency to accept proton from acids. Basic strength of different amines is compared on the basis of their K_b .

values (basicity constant) or pK_b values.

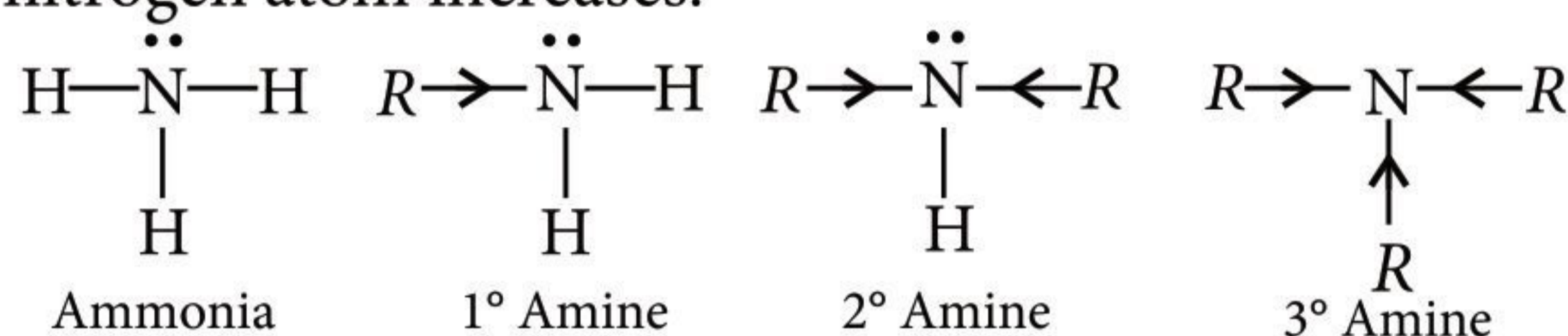
$$K_b = \frac{[RNH_3^+][OH^-]}{[RNH_2]}$$

$$pK_b = -\log K_b = \log \frac{1}{K_b}$$

Smaller the value of pK_b , or greater the value of K_b , stronger is the base.

Basic Strength of Ammonia and Aliphatic Amines

Aliphatic amines are stronger bases than ammonia because alkyl groups exert electron donating inductive effect (+I effect) on nitrogen, so that electron density on nitrogen atom increases.



Secondly, cation formed after accepting a proton from acid is also stabilised by +I effect in aliphatic amines.

Thus, basic strength of amines should follow the order :

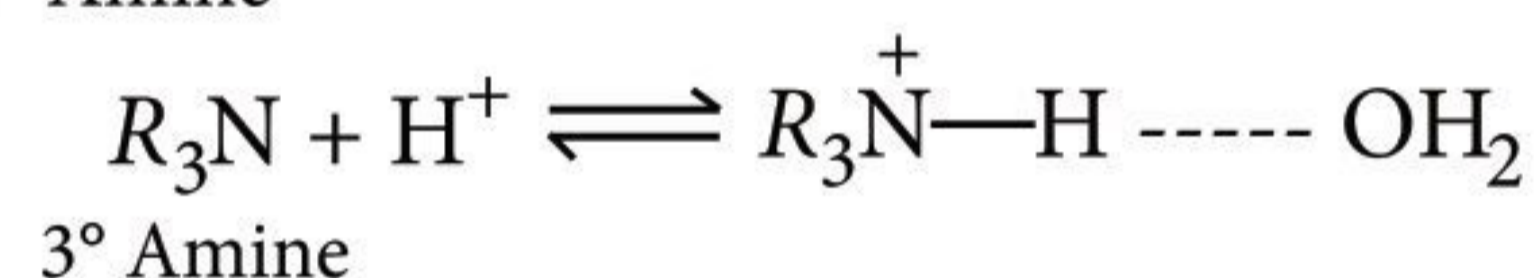
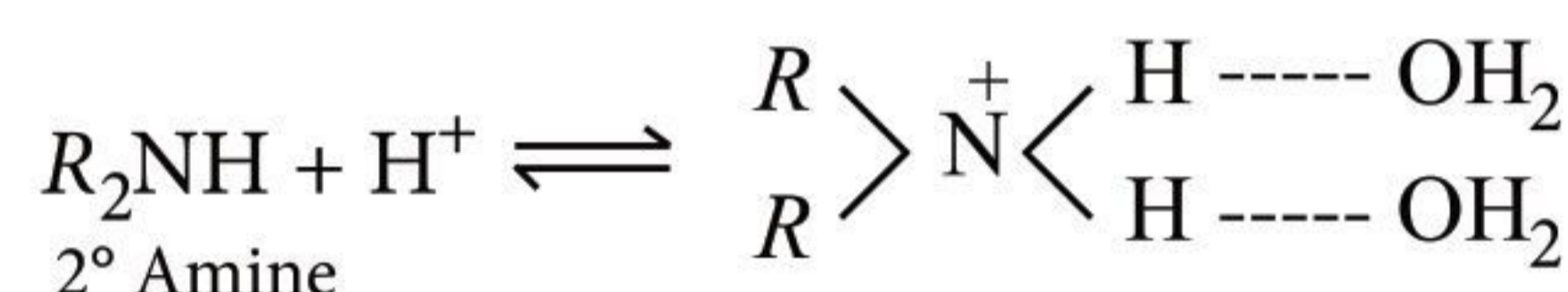
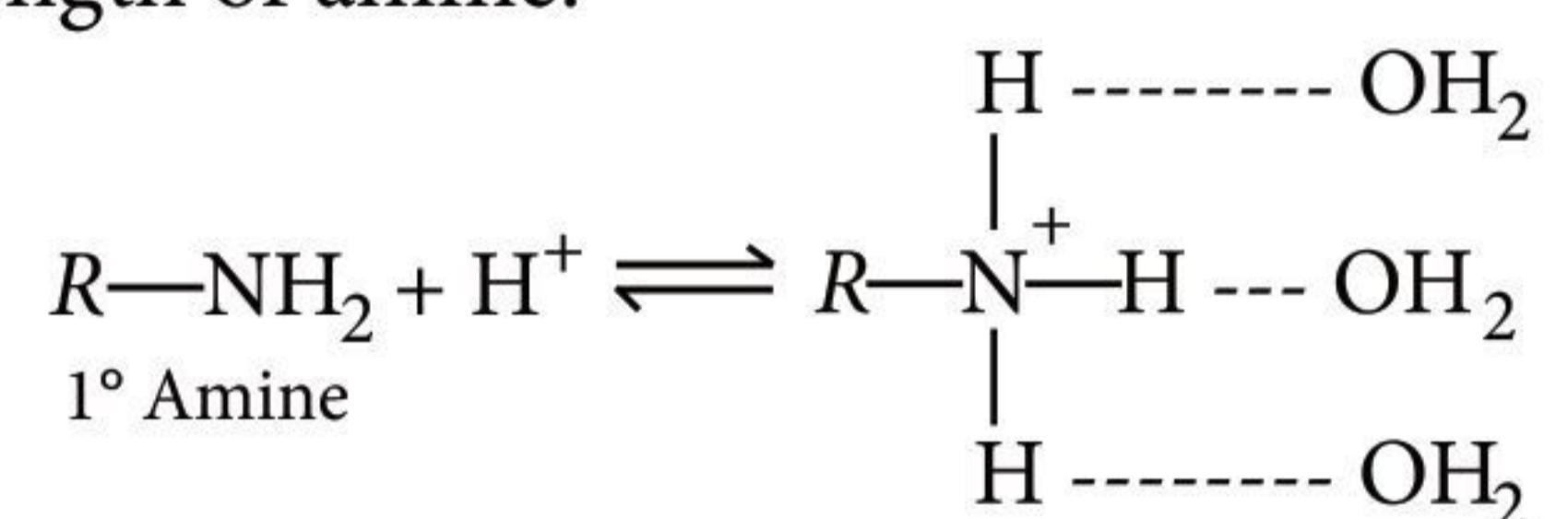


But aqueous solutions of amines do not follow above order. Basic strength of different alkyl amines depends on following factors :

- **+ I effect** : +I effect of alkyl groups tend to increase the electron density on nitrogen atom and hence the basic strength. Thus, basic strength should follow the order : $3^\circ > 2^\circ > 1^\circ$.

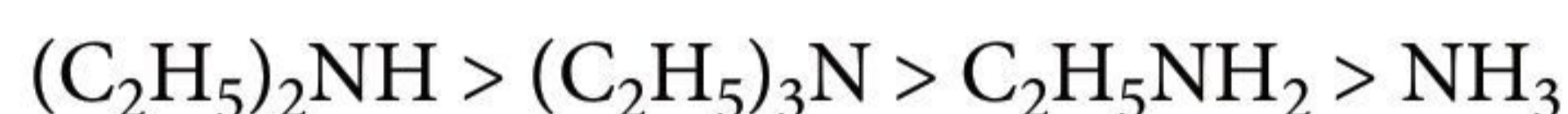
- **Steric effect** : Presence of alkyl group hinders the attack of acid on amine, thus reduces the basic strength. Greater the number of bulky alkyl groups attached to nitrogen, less will be the basic strength. Thus, basic strength should follow the order : $1^\circ > 2^\circ > 3^\circ$.

- **Solvation effect** : Amines get protonated by accepting a H^+ ion from aqueous solution and thus, form ammonium cation. These ammonium cations are stabilised by intermolecular H-bonding. Greater the number of H-atoms on N-atom, greater will be extent of hydrogen bonding and thus, higher will be the stability of ammonium cation. Stability of ammonium cation directly explains the basic strength of amine.

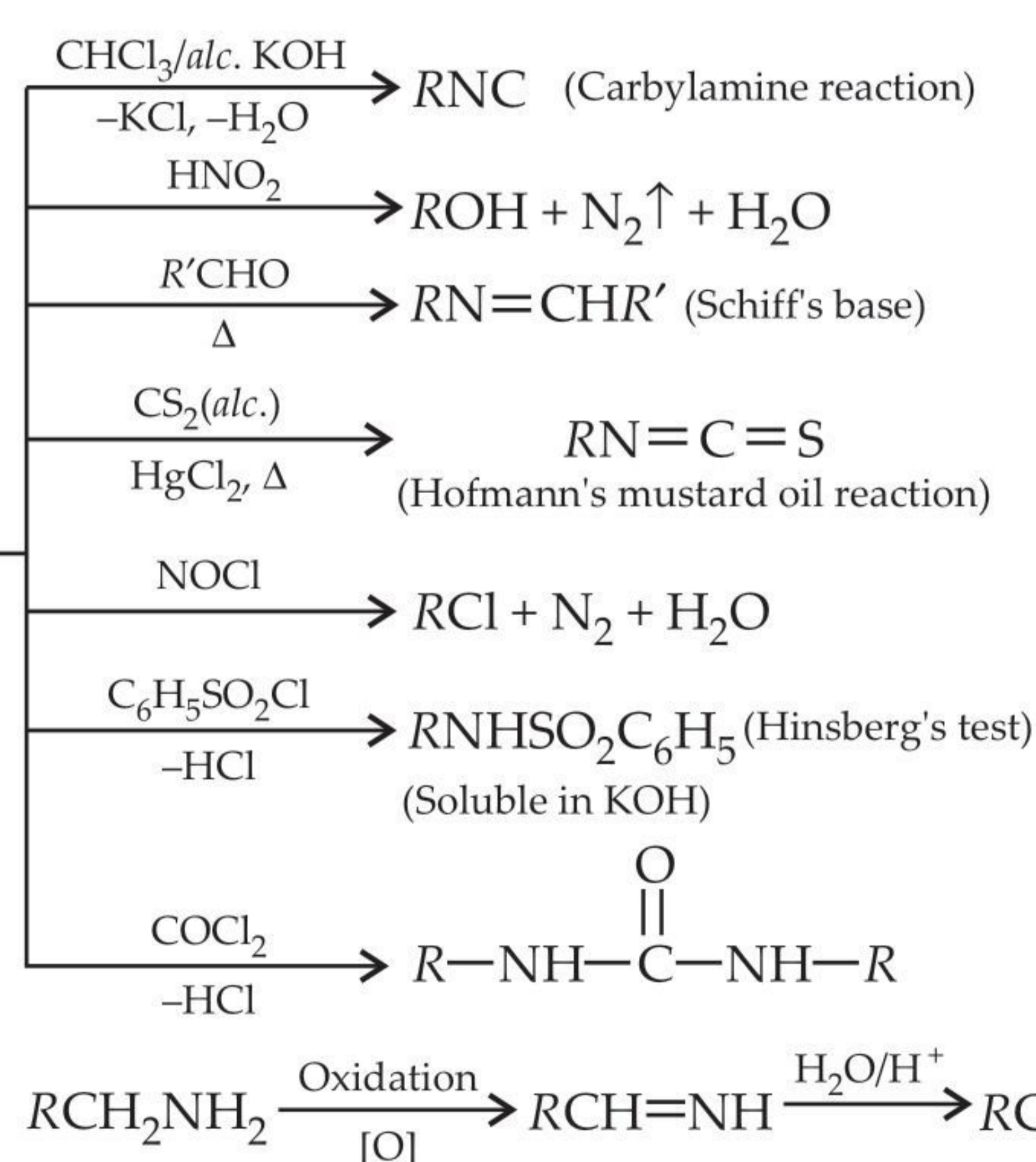
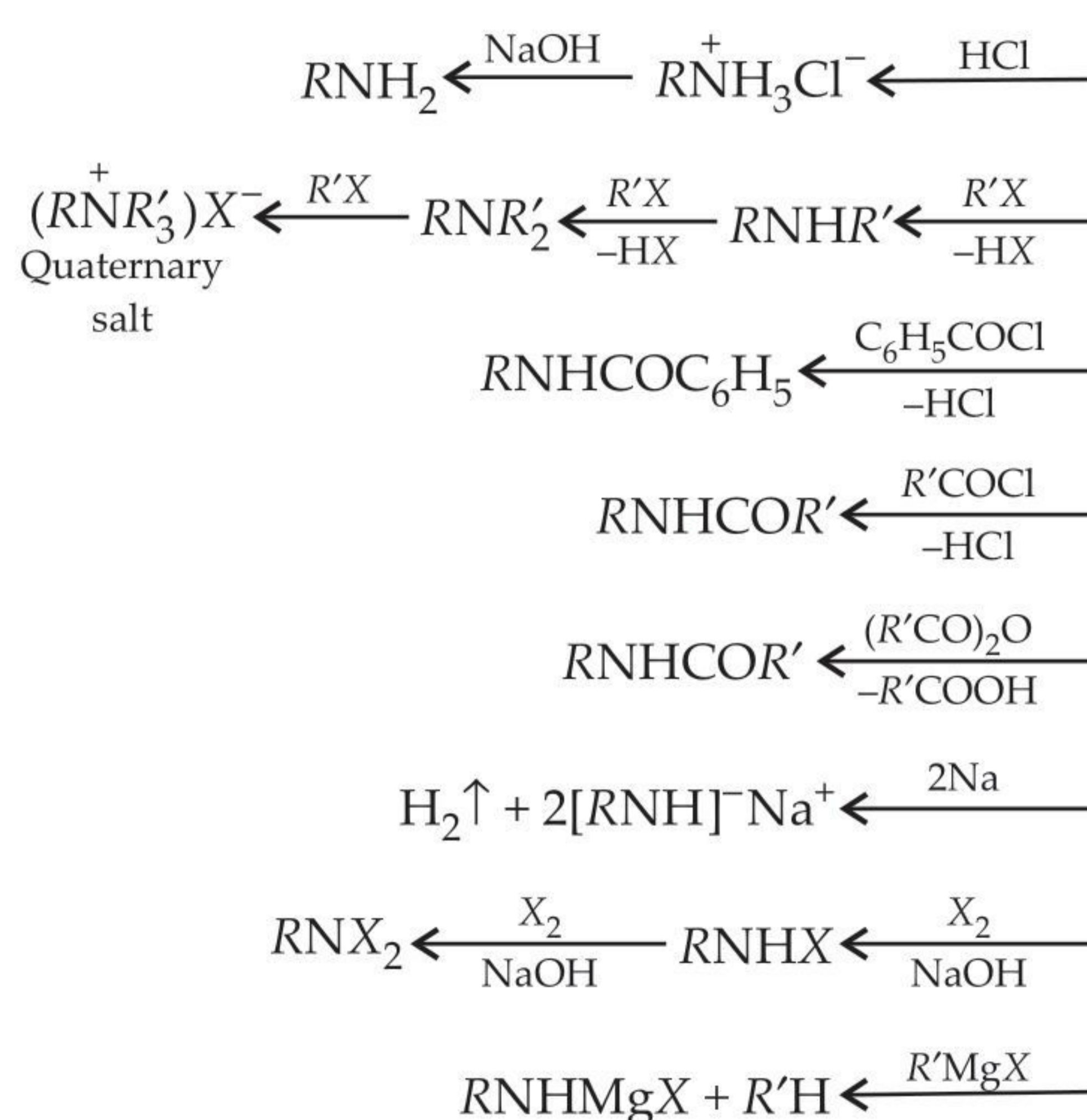


Thus, basic strength of different amines should follow the order, $1^\circ \text{ amines} > 2^\circ \text{ amines} > 3^\circ \text{ amines}$.

Hence, order of basic strength of different alkyl amines in their aqueous solution is given by the combined effect of all these factors:



Chemical Reactions



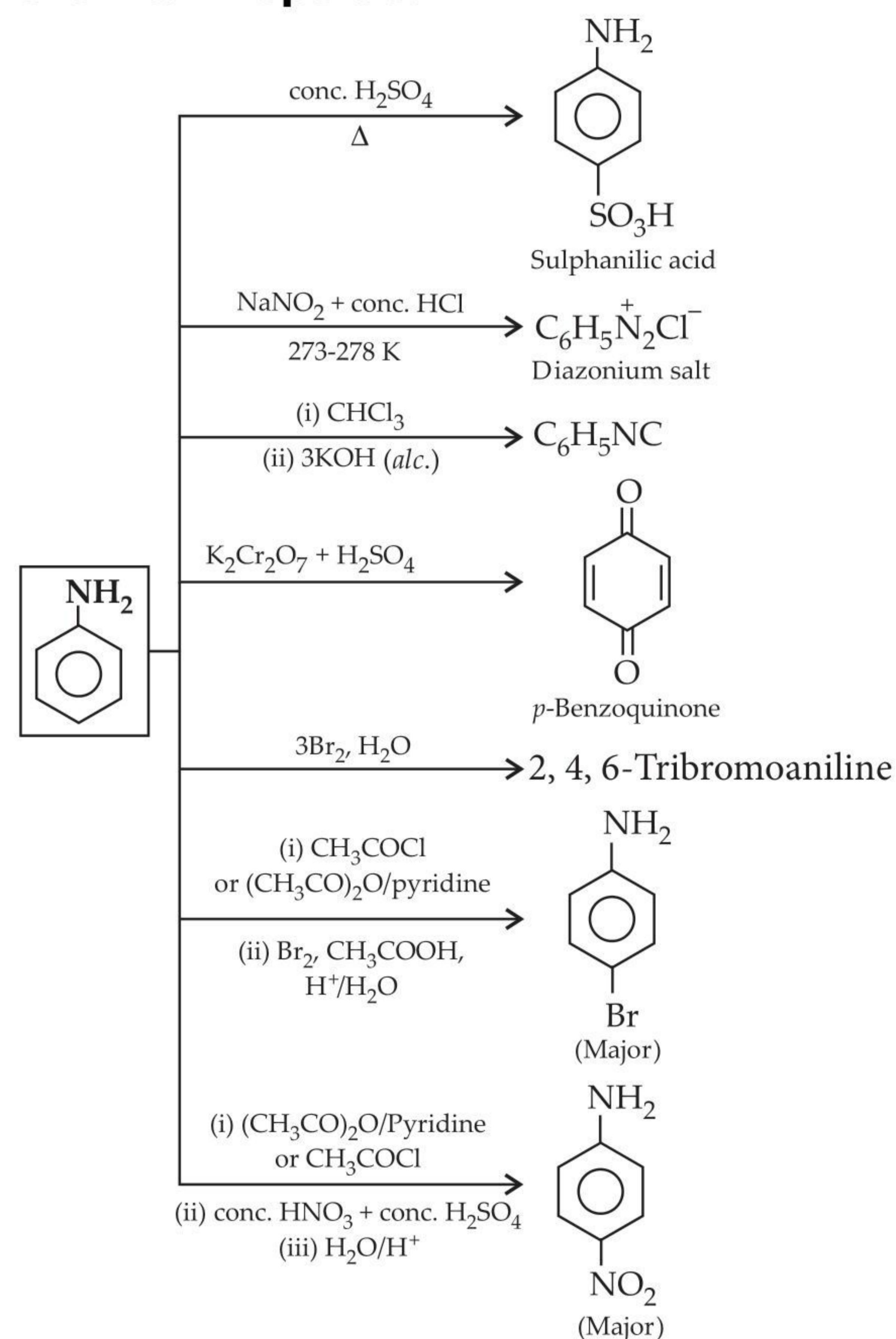
Distinction between 1°, 2° and 3° Amines

Test	Aliphatic			Aromatic
	1°	2°	3°	
Carbylamine test	Bad smelling carbylamine is formed.	No reaction	No reaction	Only aromatic primary amines give this test.
Mustard oil test	Alkyl isothiocyanate is formed.	No reaction	No reaction	Only aromatic primary amines give this test.
Hoffmann's test	Forms solid dialkyl oxamide.	Forms liquid dialkyl oxamic ester.	No reaction	
Hinsberg's test	Monoalkyl sulphonamide is formed which is soluble in KOH.	Dialkyl sulphonamide is formed which is insoluble in KOH.	No reaction	No reaction
Azo dye test	No reaction	No reaction	No reaction	Only primary aromatic amines give this test.

ANILINE

- Aromatic amino compound in which the nitrogen atom of amino group is directly attached to aromatic ring.

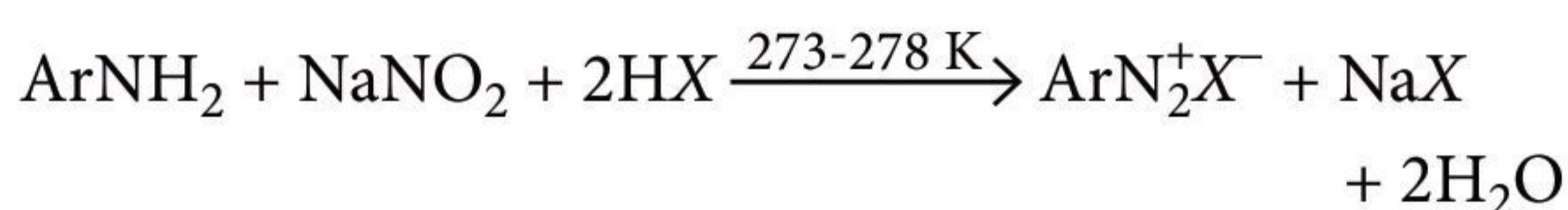
Chemical Properties



DIAZONIUM SALTS

- These have the general formula, ArN_2^+X^- , where Ar is abbreviated for the aryl group and X^- can be Cl^- , Br^- , HSO_4^- , NO_3^- , etc.

Preparation

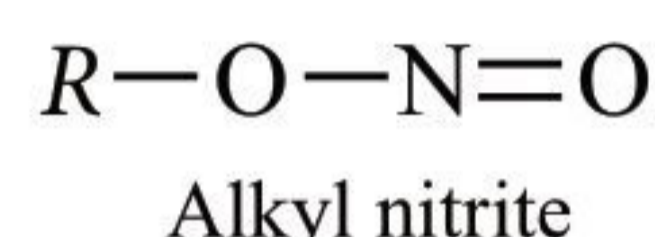
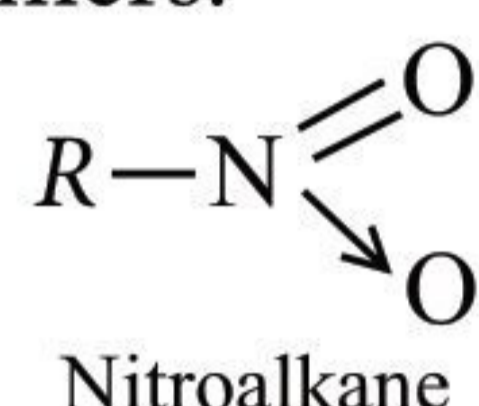


Chemical Properties

D	Balz-Schiemann reaction
I	$\xrightarrow[\text{-HCl}]{\text{HBF}_4} \text{ArN}_2^+\text{BF}_4^- \xrightarrow{\Delta} \text{ArF} + \text{N}_2 + \text{BF}_3$
A	Gomberg Bachmann reaction
Z	$\xrightarrow[\text{NaOH, } \Delta]{\text{C}_6\text{H}_6} \text{Ar}-\text{C}_6\text{H}_5 + \text{HCl} + \text{N}_2 \uparrow$ (Diphenyl)
O	$\xrightarrow[\text{or CH}_3\text{CH}_2\text{OH}/\Delta]{\text{H}_3\text{PO}_2/\text{Cu}^+} \text{ArH}$
N	
I	Sandmeyer's reaction
U	$\xrightarrow{\text{CuBr/HBr}} \text{ArBr} + \text{N}_2$
M	Gattermann reaction
S	$\xrightarrow{\text{Cu/HBr}} \text{ArBr} + \text{N}_2$
A	Coupling reaction
L	$\xrightarrow[\text{pH} = 9-10, 0-5^\circ\text{C}]{\text{C}_6\text{H}_5\text{OH}/\text{OH}^-} \text{ArN}=\text{NC}_6\text{H}_4\text{OH}$
T	Reduction
S	$\xrightarrow[\text{HCl}]{\text{SnCl}_2} \text{ArNH}-\text{NH}_2$ Aryl hydrazine

NITRO COMPOUNDS

- These may be aliphatic or aromatic compounds according to nitro group attached to alkyl or aryl group. *e.g.* CH_3NO_2 , $\text{C}_6\text{H}_5\text{NO}_2$.
- Nitroalkanes are isomeric with the alkyl nitrites, $\text{R}-\text{O}-\text{N}=\text{O}$, in which alkyl or aryl group is attached to $-\text{NO}_2$ group. Thus, $-\text{NO}_2$ group forms isomers.

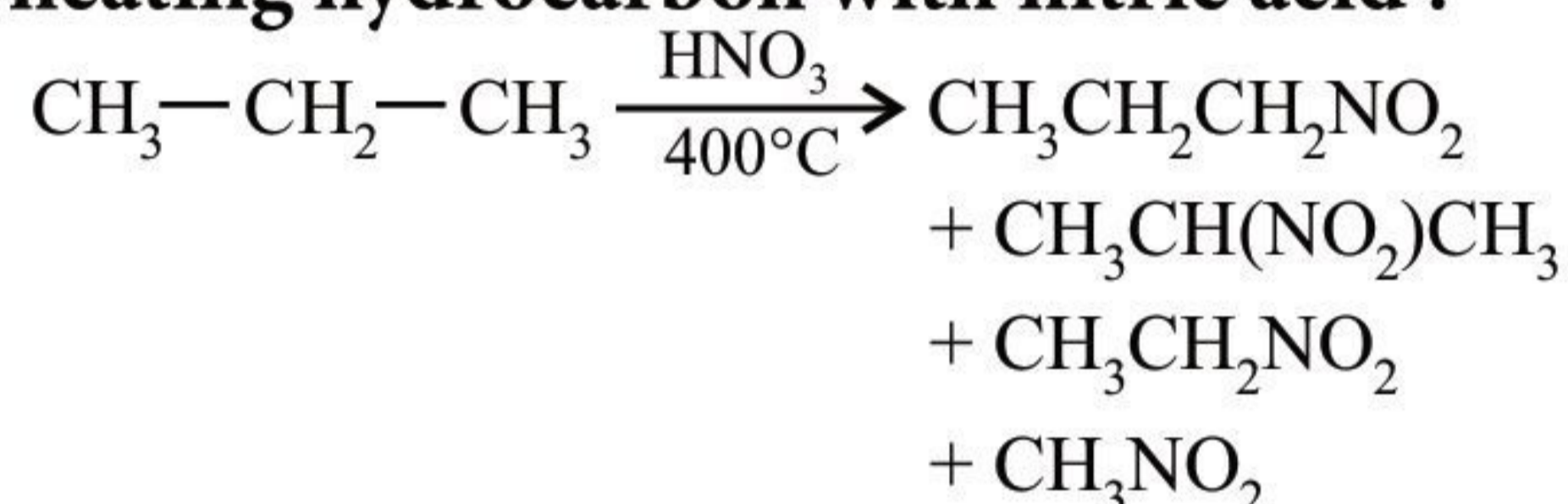


Preparation

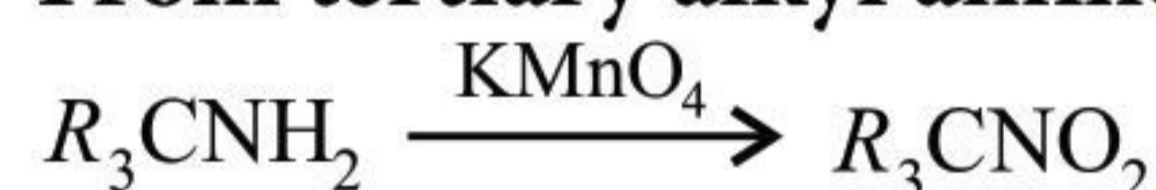
- By heating alkyl halide with AgNO_2 in aqueous ethanolic solution :



- By heating hydrocarbon with nitric acid :



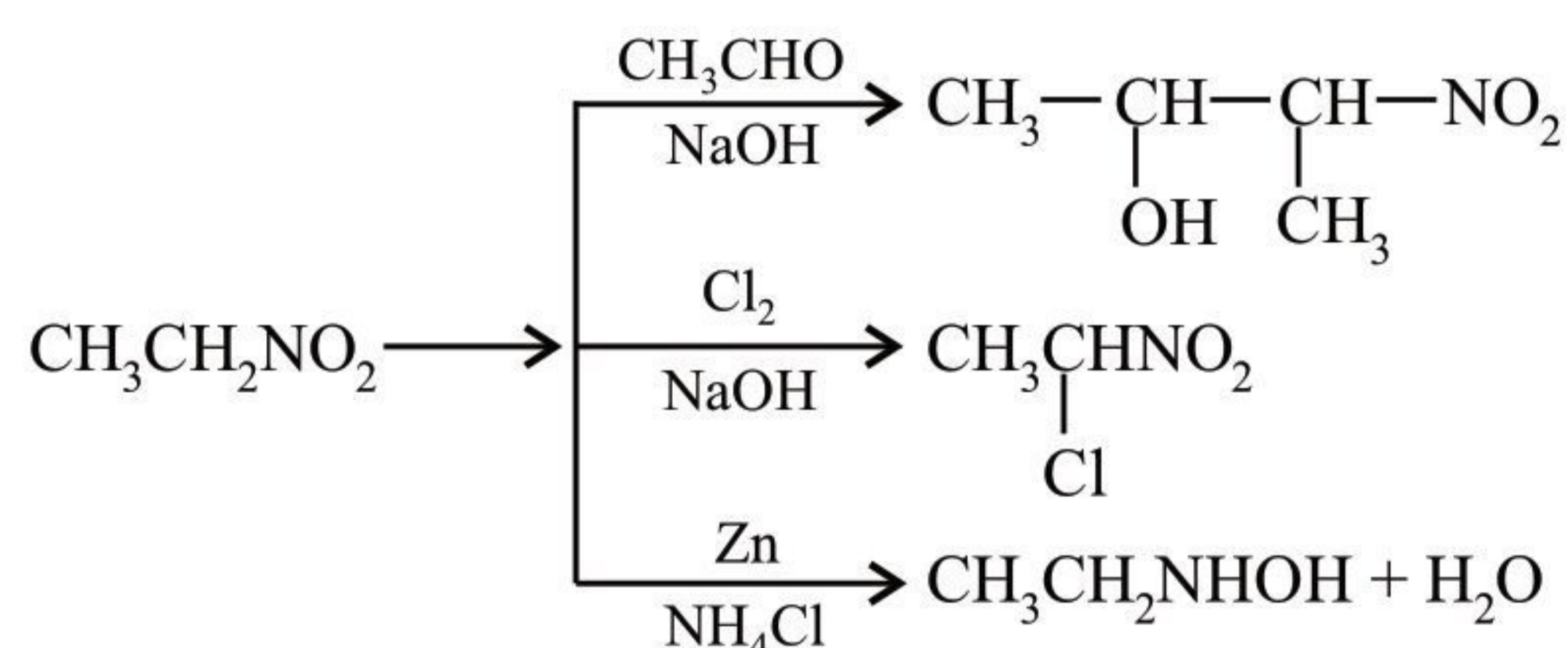
- From tertiary alkyl amine :



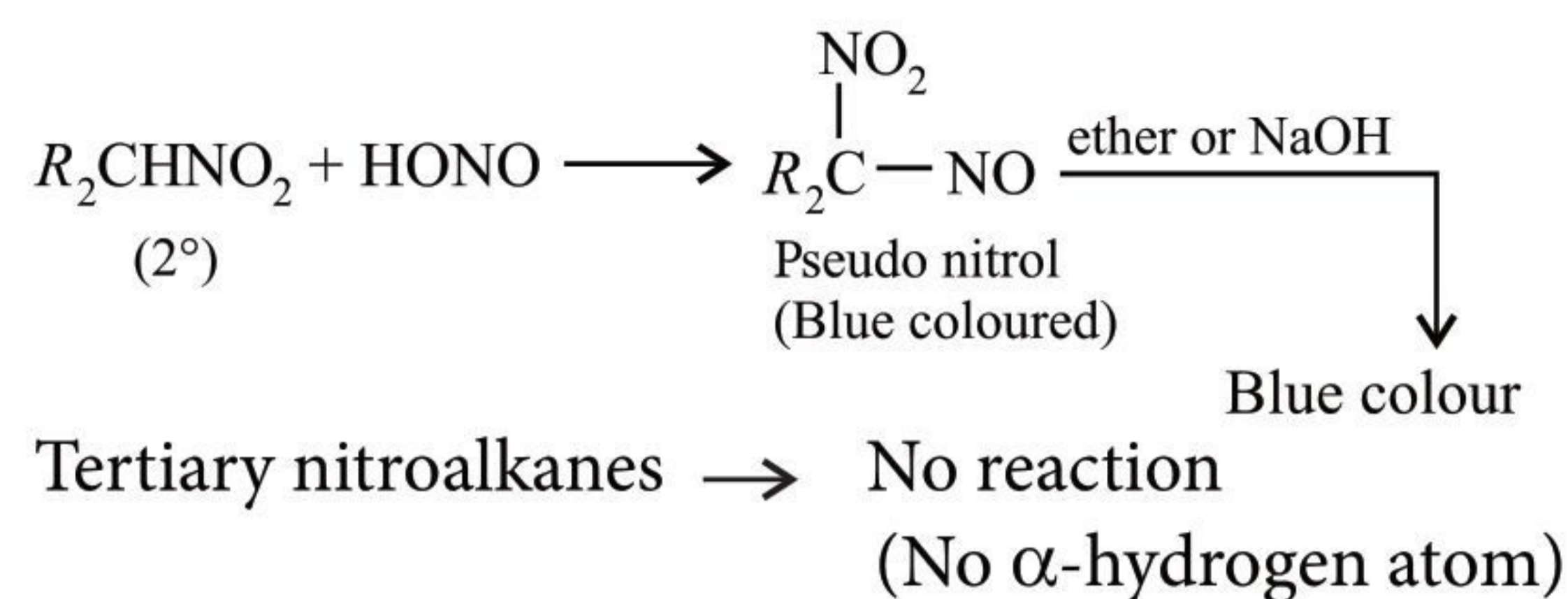
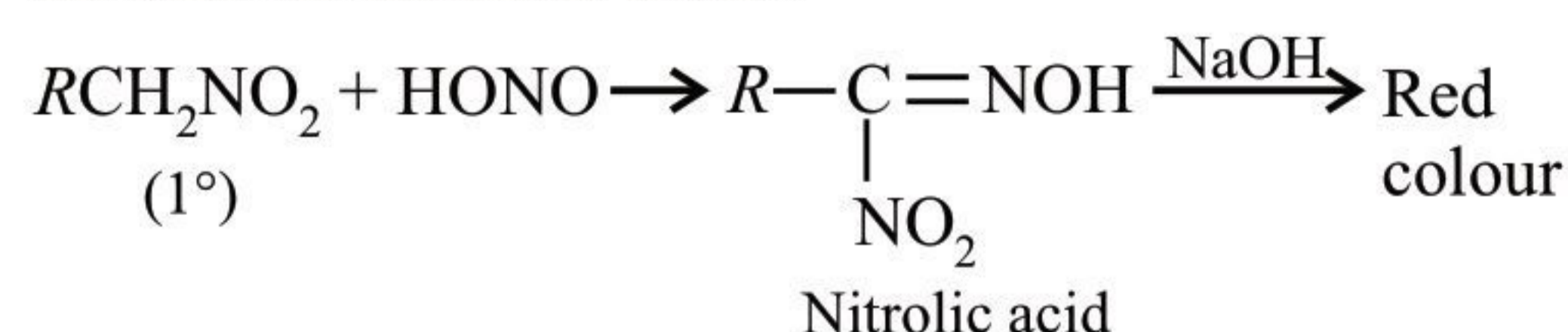
Physical Properties

- Nitroalkanes are colourless, pleasant smelling liquids.
- Both aliphatic and aromatic nitro compounds have high boiling points.
- They are less soluble in water but readily soluble in organic solvents.
- They are quite stable and therefore, they can be distilled smoothly without decomposition under atmospheric pressure, unlike isomeric alkyl nitrites which explode on heating.

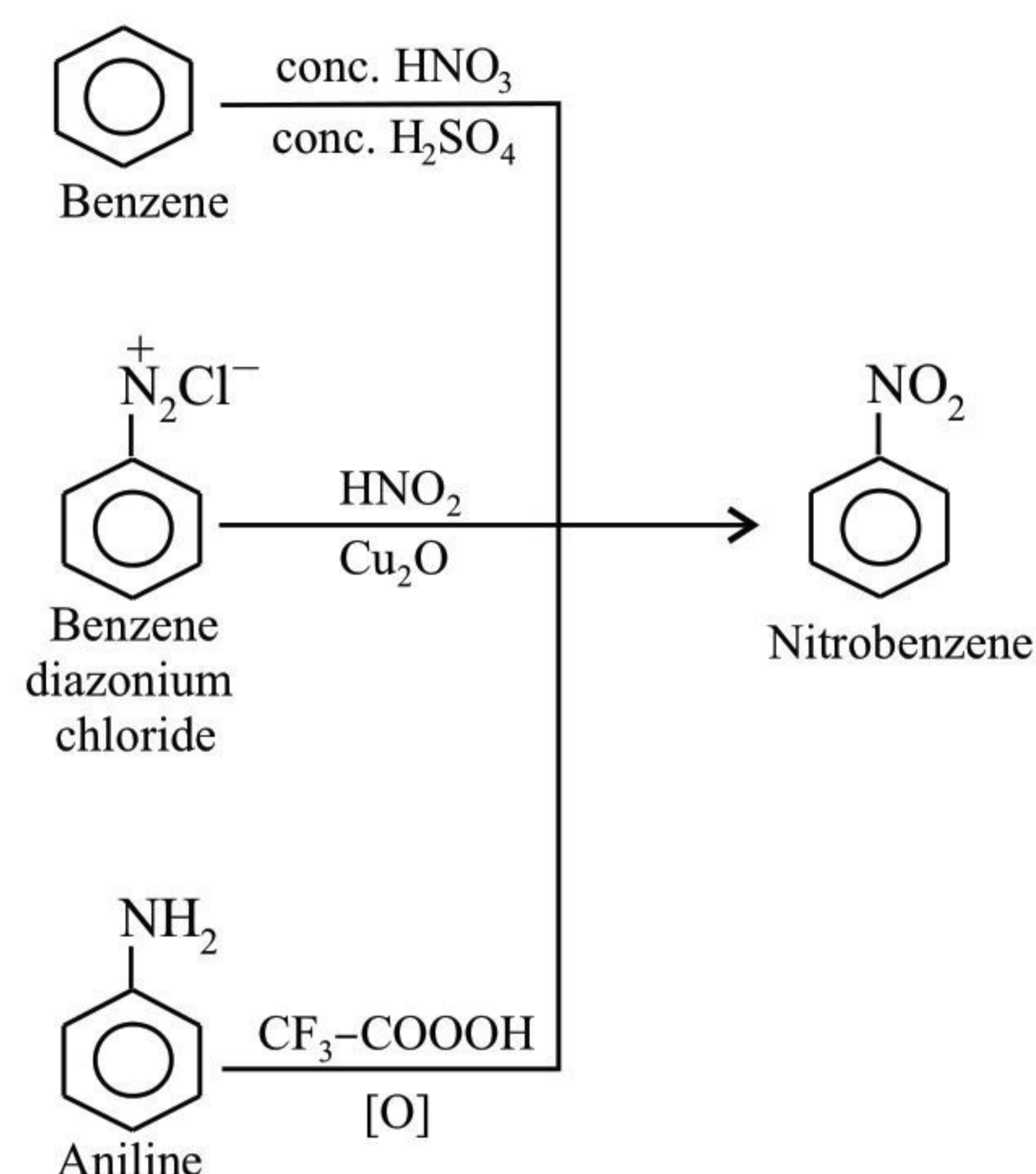
Chemical Properties




- Action of nitrous acid :



Preparation of Nitrobenzene



- Nitration of arene is an electrophilic substitution reaction. The electrophile is nitronium ion (NO_2^+). Concentrated H_2SO_4 helps in generating the electrophile from nitric acid (HNO_3) behaves as a Lewis base in this reaction.



NEET

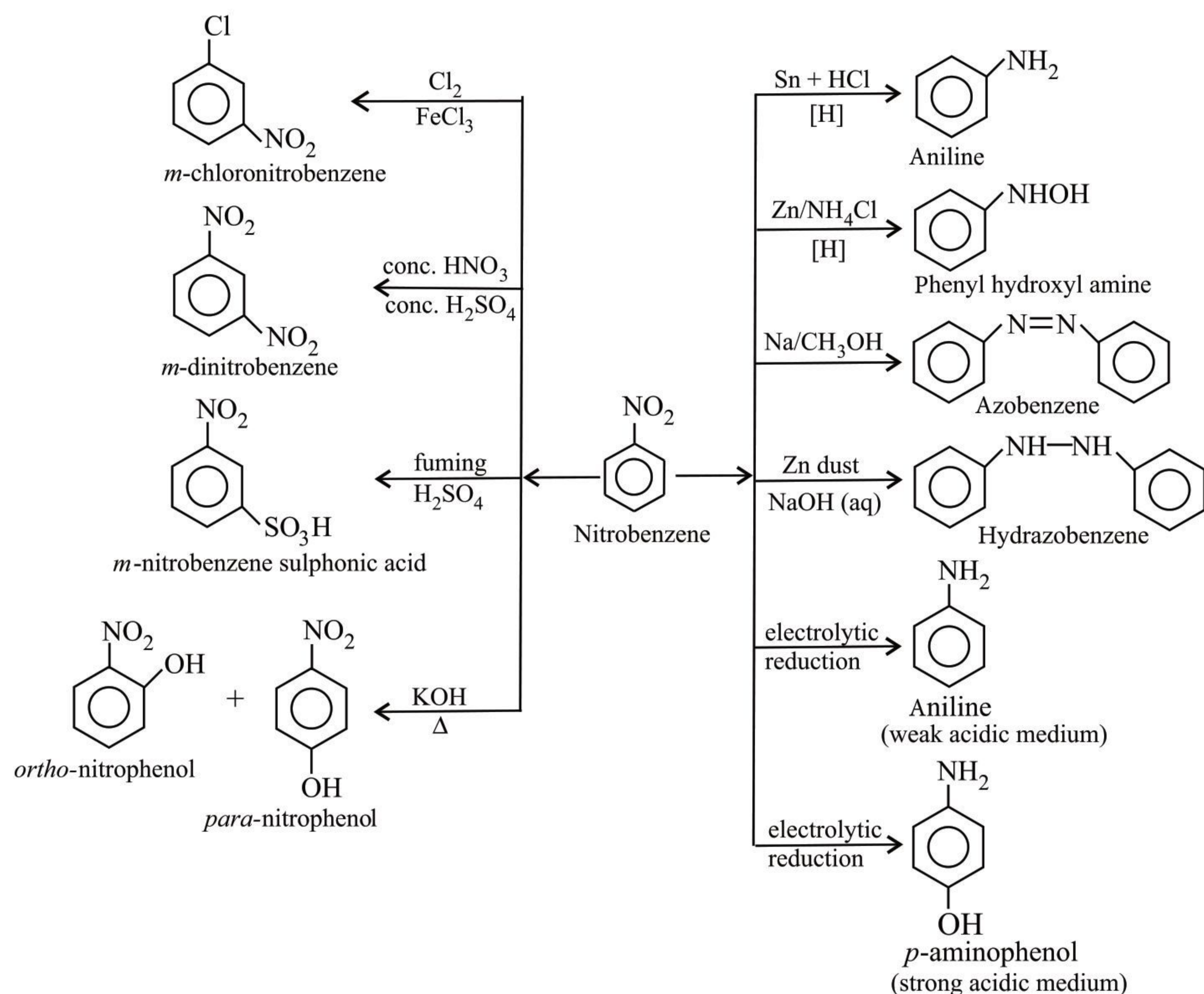
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• **Chemical properties of nitrobenzene :**



CYANIDES

- These are represented as $R-C\equiv N$.
- Alkyl cyanides are also known as *nitriles* or *carbonitriles*.

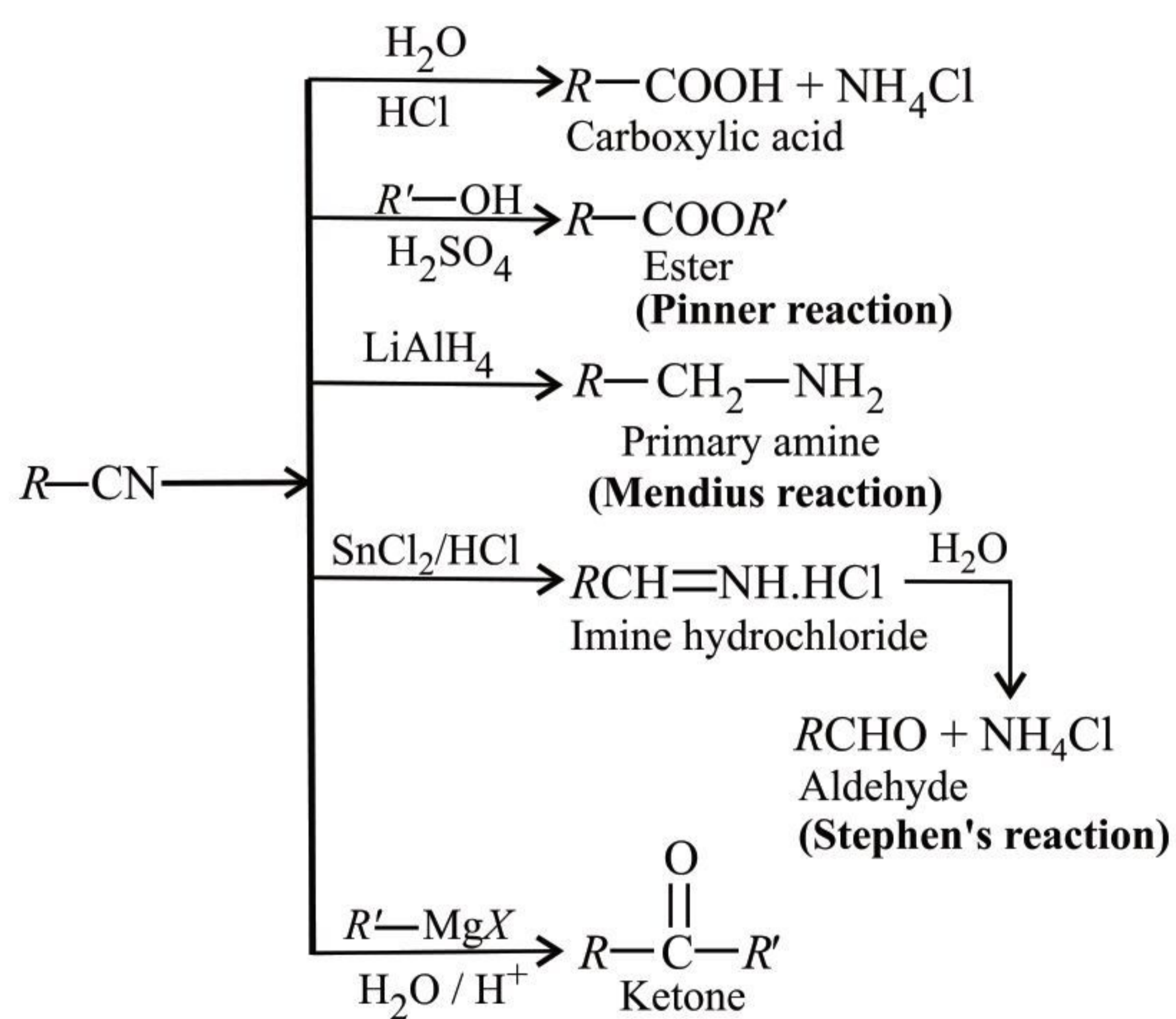
Preparation

- **By the dehydration of acid amides with P_2O_5 :**
 $RCONH_2 + P_2O_5 \xrightarrow{\Delta} RCN + H_2O$
- **By the dehydration of aldoximes with acetic anhydride :**
 $RCH=NOH \xrightarrow{(CH_3CO)_2O} RCN + H_2O$
- **By heating alkyl halide with KCN in aqueous ethanolic solution :**
 $RX + KCN \rightarrow RCN + KX$

Physical Properties

- Alkyl cyanides are neutral substances with pleasant odour, similar to bitter almonds.
- They are soluble in water.
- They are poisonous but less poisonous than HCN.

Chemical Properties



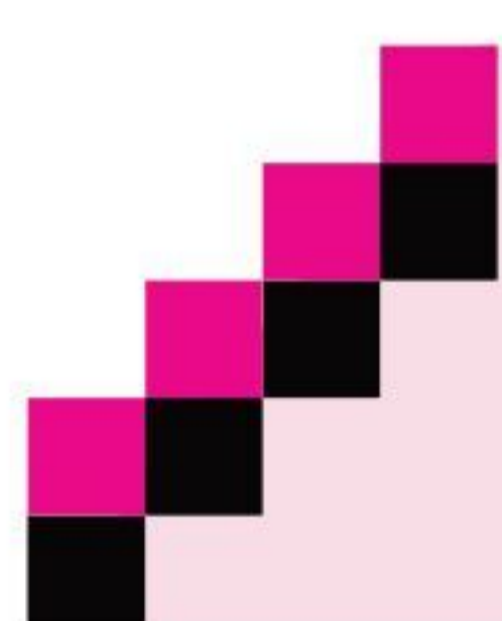
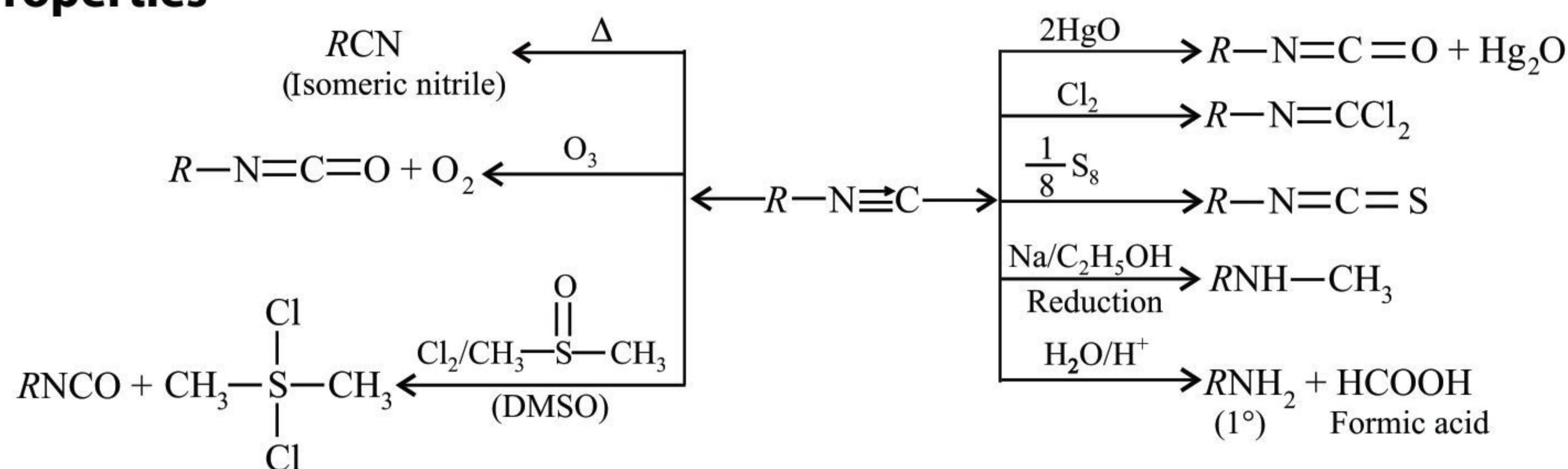
ISOCYANIDES

- These are represented as $R-N\equiv C$
- Alkyl isocyanides are also known as *isonitriles* or *carbylamines*.

Preparation

- By heating an alkyl iodide with AgCN in aqueous ethanolic solution :
 $RI + AgCN \rightarrow RNC + AgI$
- By heating a mixture of a primary amine and chloroform with ethanolic KOH :
 $RNH_2 + CHCl_3 + 3KOH \rightarrow RNC + 3KCl + 3H_2O$

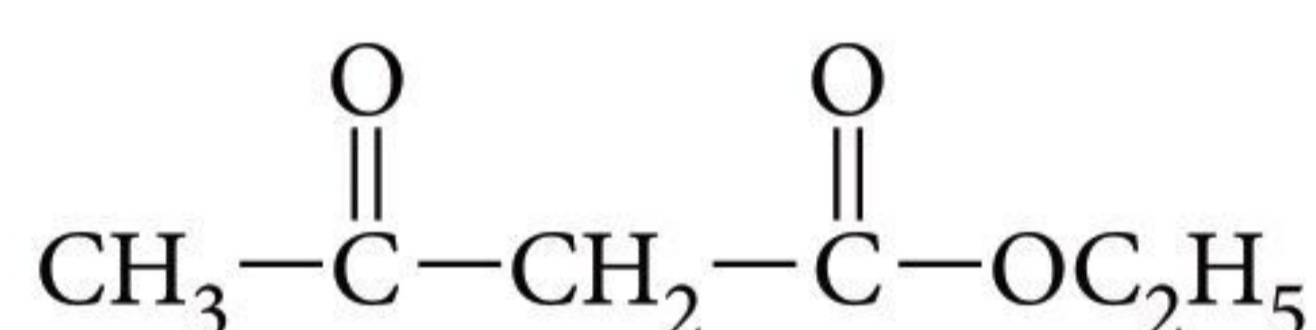
Chemical Properties



WRAP it up!

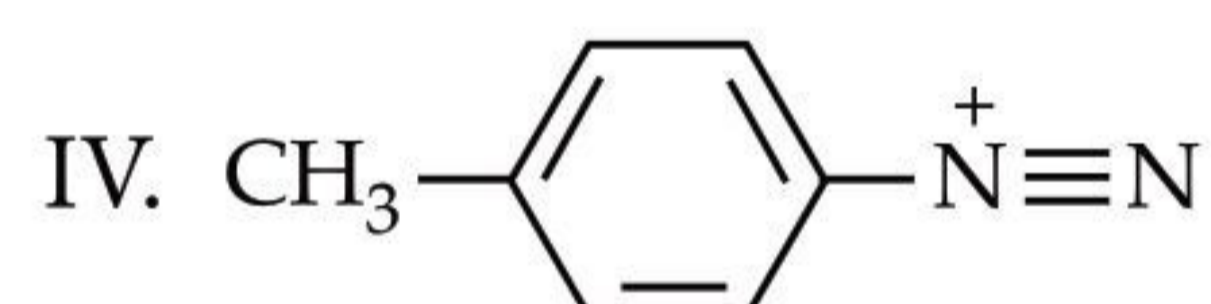
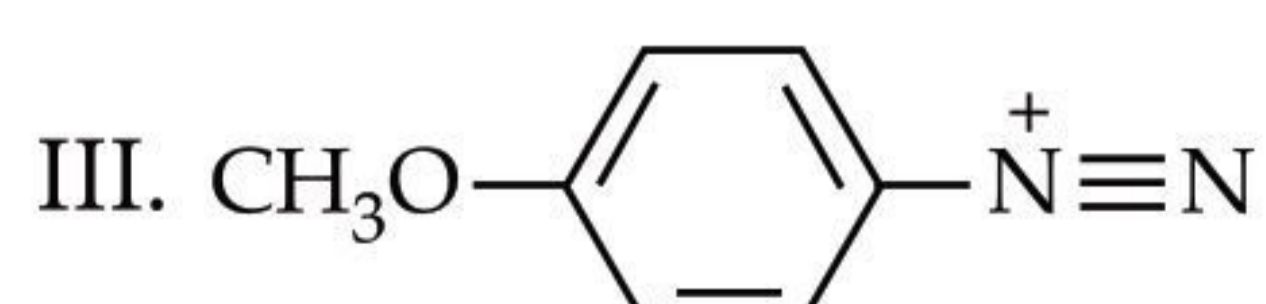
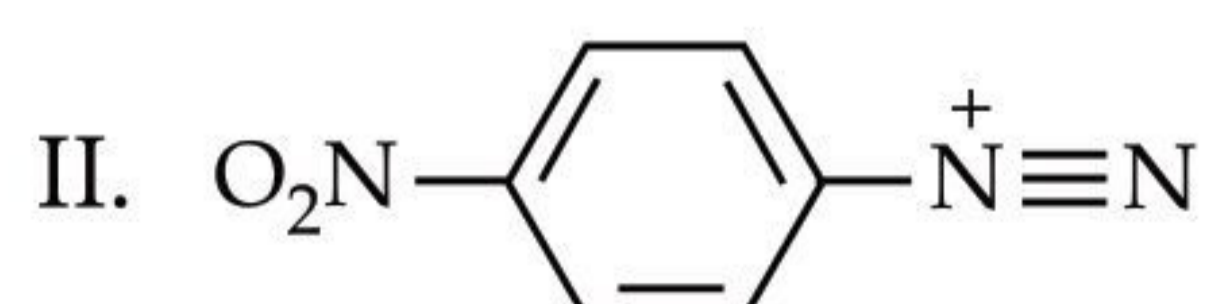
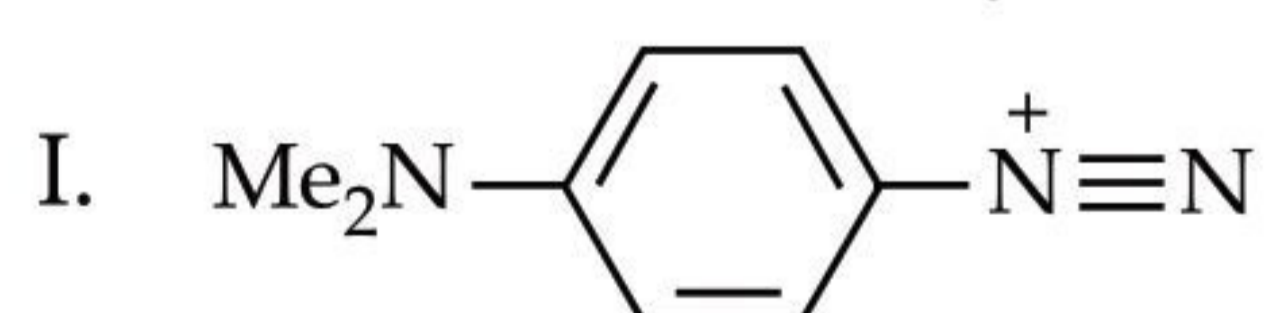
MCQs Type

1. The IUPAC name of the following compound is



- (a) ethyl β -ketobutyrate
 (b) ethyl-3-oxobutanoate
 (c) 1-carbethoxypropanone
 (d) ethyl acetoacetate.
2. Which of the following statements is incorrect?
 (a) Aniline is more acidic than ammonia.
 (b) $F-C_6H_4-NH_3^+$ is less acidic than $C_6H_5-NH_3^+$
 (c) Amines are less acidic than alcohols of comparable molecular masses.
 (d) $RCONH_2$ is more acidic than RCH_2NH_2

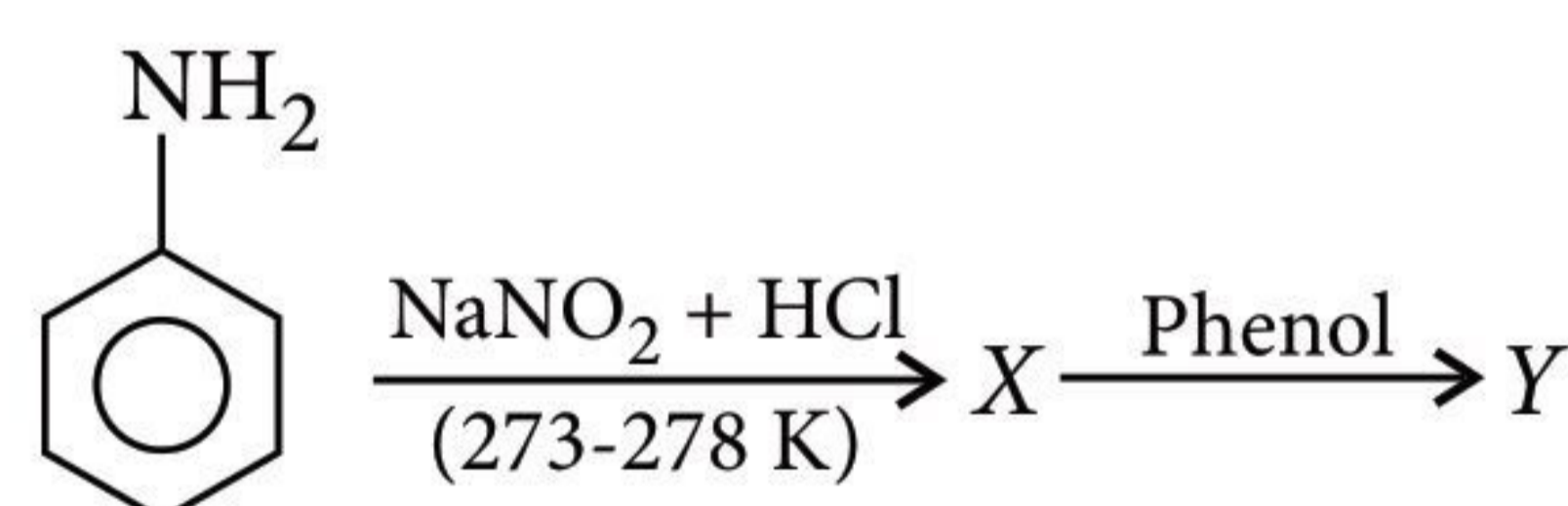
3. Consider the following ions :



The reactivity order of these ions towards azo coupling reaction under similar conditions is

- (a) $I < IV < II < III$ (b) $I < III < IV < II$
 (c) $III < I < II < IV$ (d) $III < I < IV < II$

4. Aniline in a set of the following reactions yield a coloured product Y



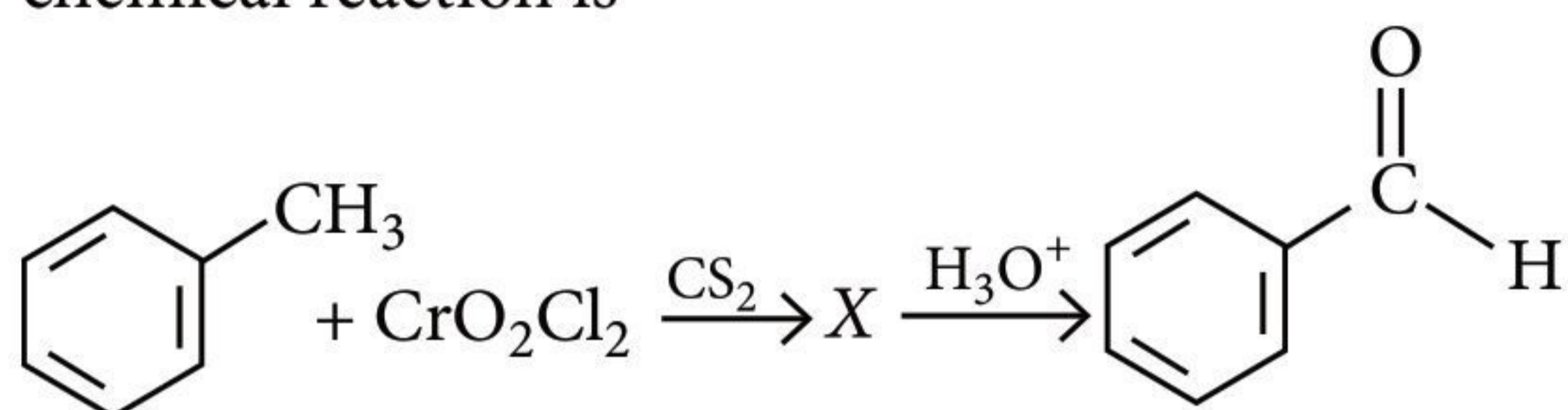
The structure of Y would be

- (a) $H_2N-C_6H_4-NH-C_6H_4-NH_2$
 (b) $C_6H_5-N=N-C_6H_4-OH$
 (c) $HO-C_6H_4-N=N-C_6H_4-NH_2$
 (d) $C_6H_5-HN-NH-C_6H_4-OH$

5. Which of the following is used to distinguish between an aldehyde and a ketone?

- (a) Concentrated H_2SO_4
- (b) Hydrazine
- (c) Tollens' reagent
- (d) Nitrous acid

6. The intermediate compound X in the following chemical reaction is



- (a)
- (b)
- (c)
- (d)

(NEET 2021)

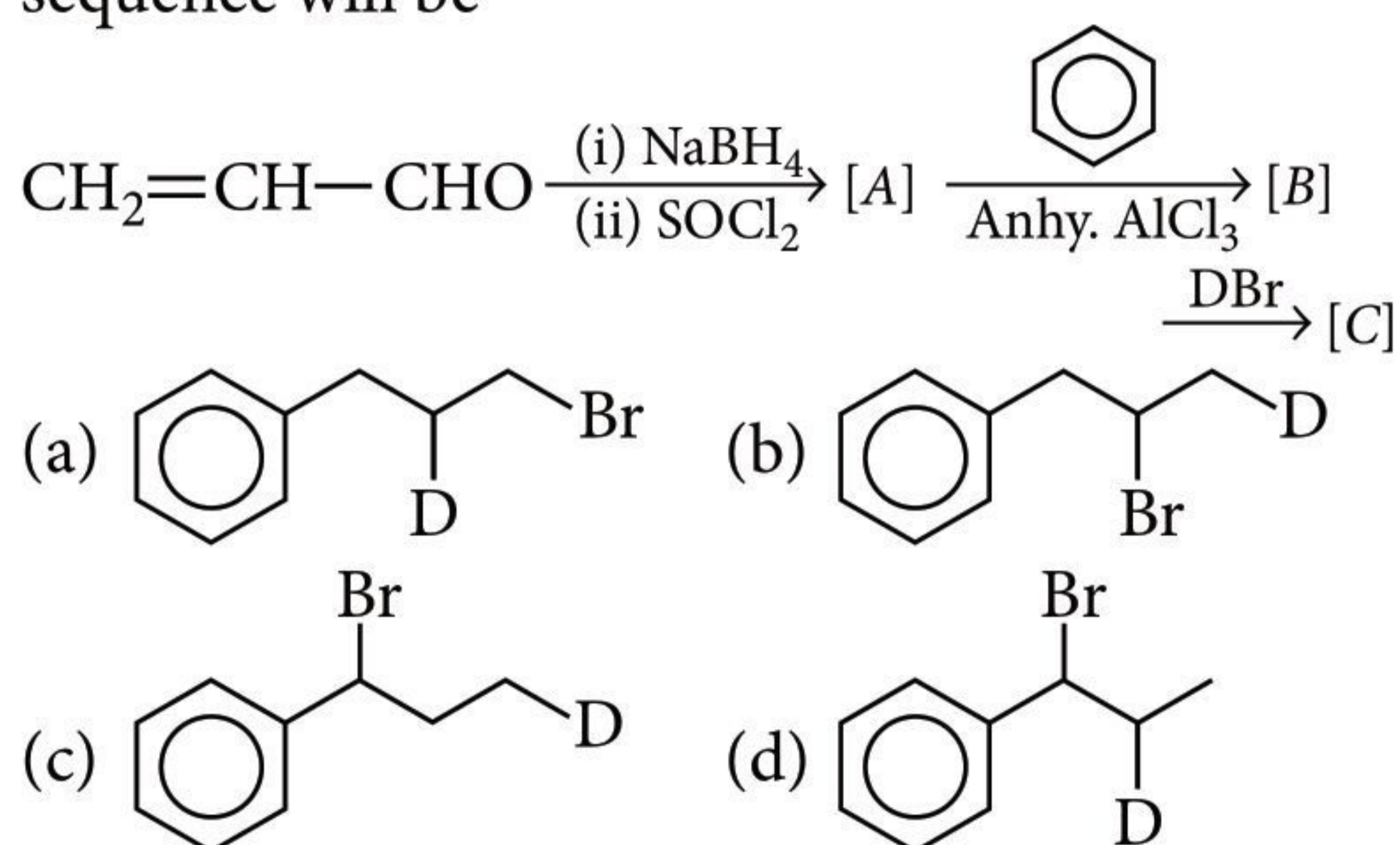
7. On treatment with 1% HgSO_4 and 20% H_2SO_4 , but-1-yne gives

- (a) $\text{CH}_3\text{CH}_2\text{COCH}_3$
- (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$
- (c) $\text{CH}_3\text{CH}_2\text{CHO}$ and HCHO
- (d) $\text{CH}_3\text{CH}_2\text{COOH}$ and HCOOH

8. On reaction with aqueous HNO_2 at low temperature, a compound produces an oily nitrosamine. The compound is likely to be

- (a) methylamine
- (b) ethylamine
- (c) diethylamine
- (d) triethylamine.

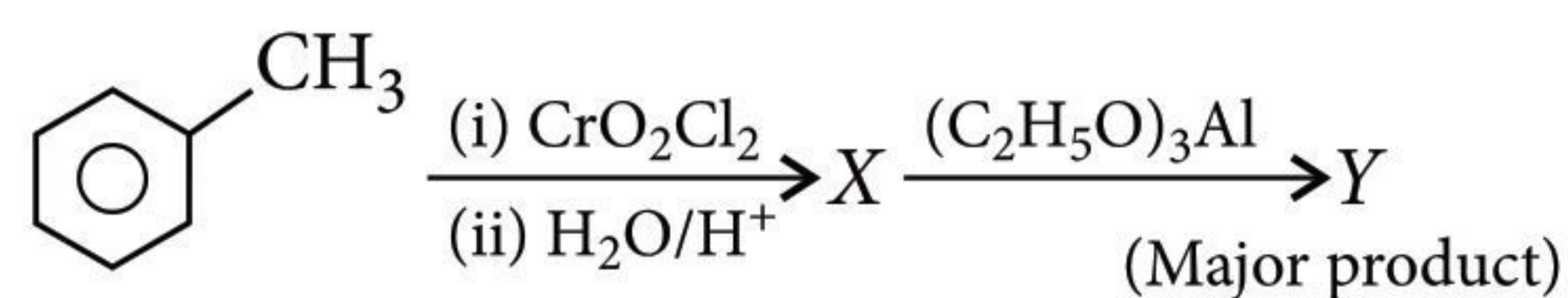
9. The major product [C] of the following reaction sequence will be



- (a)
- (b)
- (c)
- (d)

(JEE Main 2020)

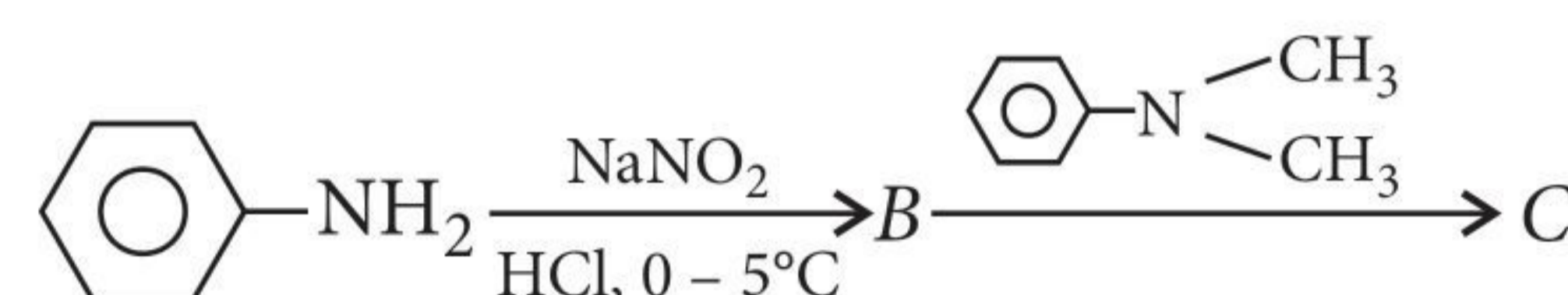
10. Study the given sequence of reactions :



Here, Y is

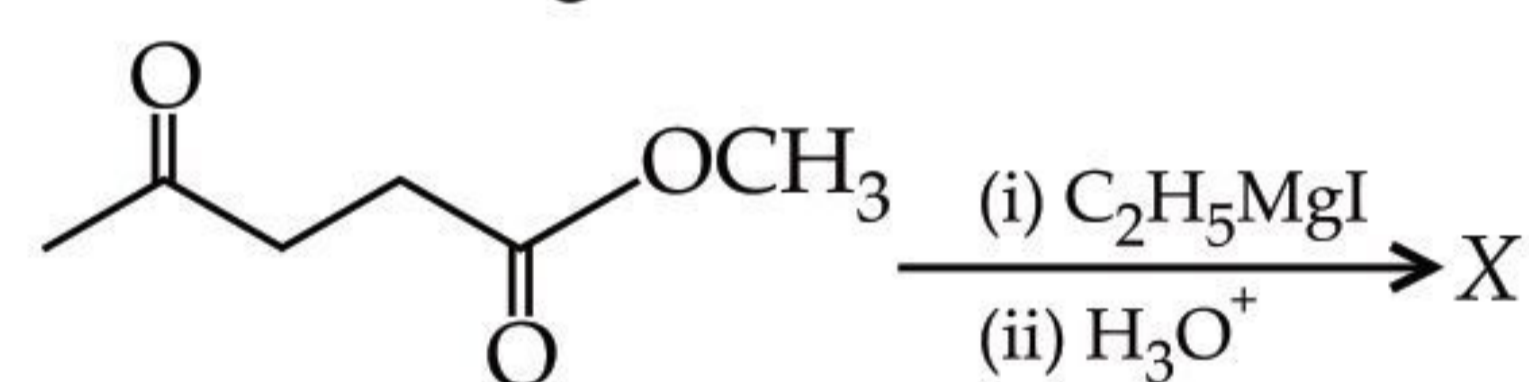
- (a)
- (b)
- (c)
- (d)

11. In a reaction of aniline a coloured compound 'C' was obtained. The structure of 'C' would be



- (a)
- (b)
- (c)
- (d)

12. Give the structure of the compound X formed in the following reaction :



- (a)
- (b)
- (c)
- (d)

13. An organic compound 'A' having molecular formula, $\text{C}_2\text{H}_3\text{N}$ on reduction gave another compound 'B'. Upon treatment with nitrous acid 'B' gave ethyl alcohol. On warming with chloroform

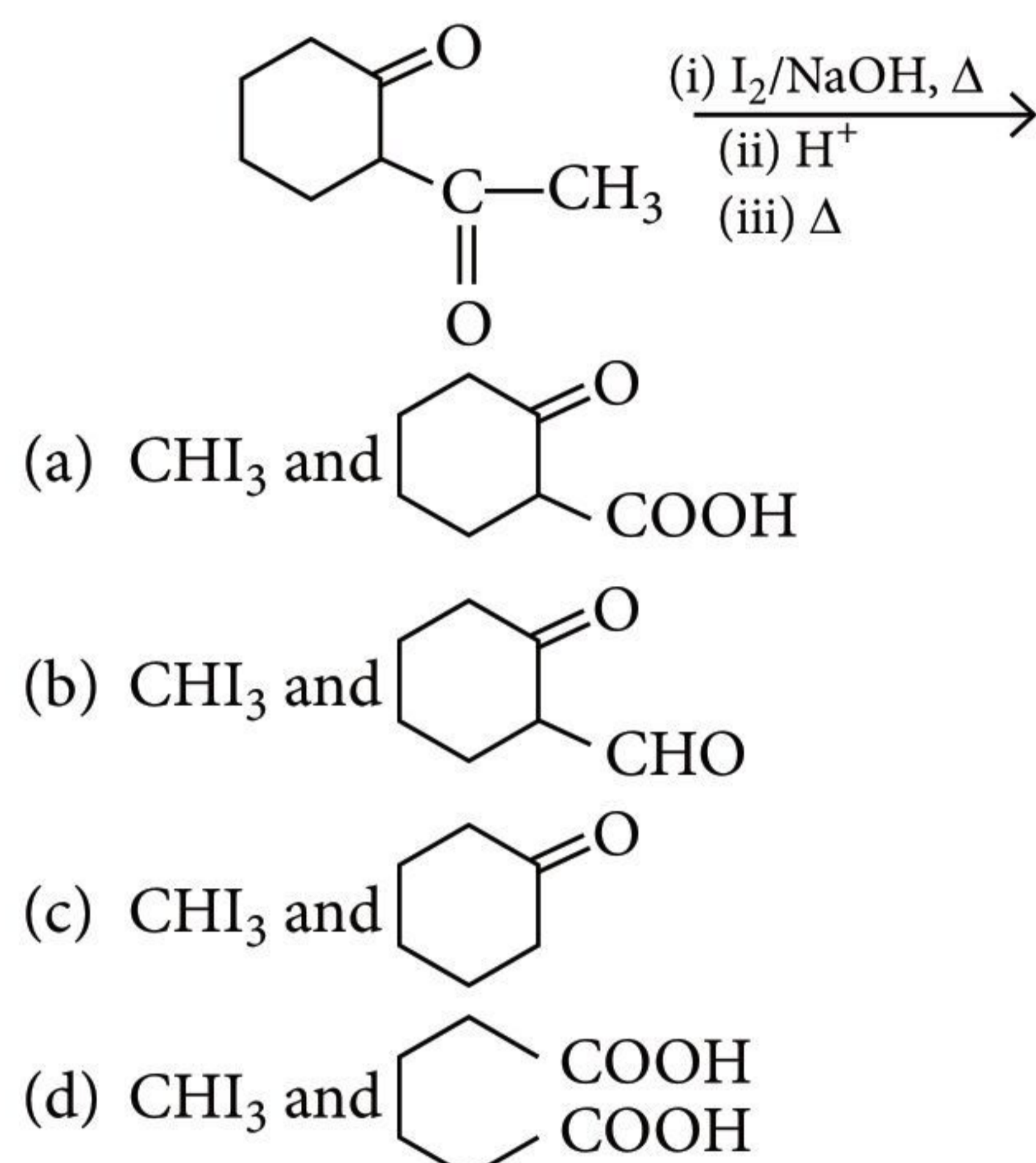
and alcoholic KOH, 'B' forms an offensive smelling compound 'C'. The compound 'C' is

- (a) $\text{CH}_3\text{CH}_2\text{NH}_2$ (b) $\text{CH}_3\text{CH}_2\text{N}\equiv\text{C}$
(c) $\text{CH}_3\text{C}\equiv\text{N}$ (d) $\text{CH}_3\text{CH}_2\text{OH}$

14. An organic compound, $\text{C}_5\text{H}_{10}\text{O}$ forms phenylhydrazone, gives positive iodoform test and undergoes Wolff-Kishner reaction to give isopentane. The compound is

- (a) pentanol (b) pentan-2-one
(c) pentan-3-one (d) 3-methylbutan-2-one.

15. What is the end product in this sequence of reactions?



16. Given below are two statements :

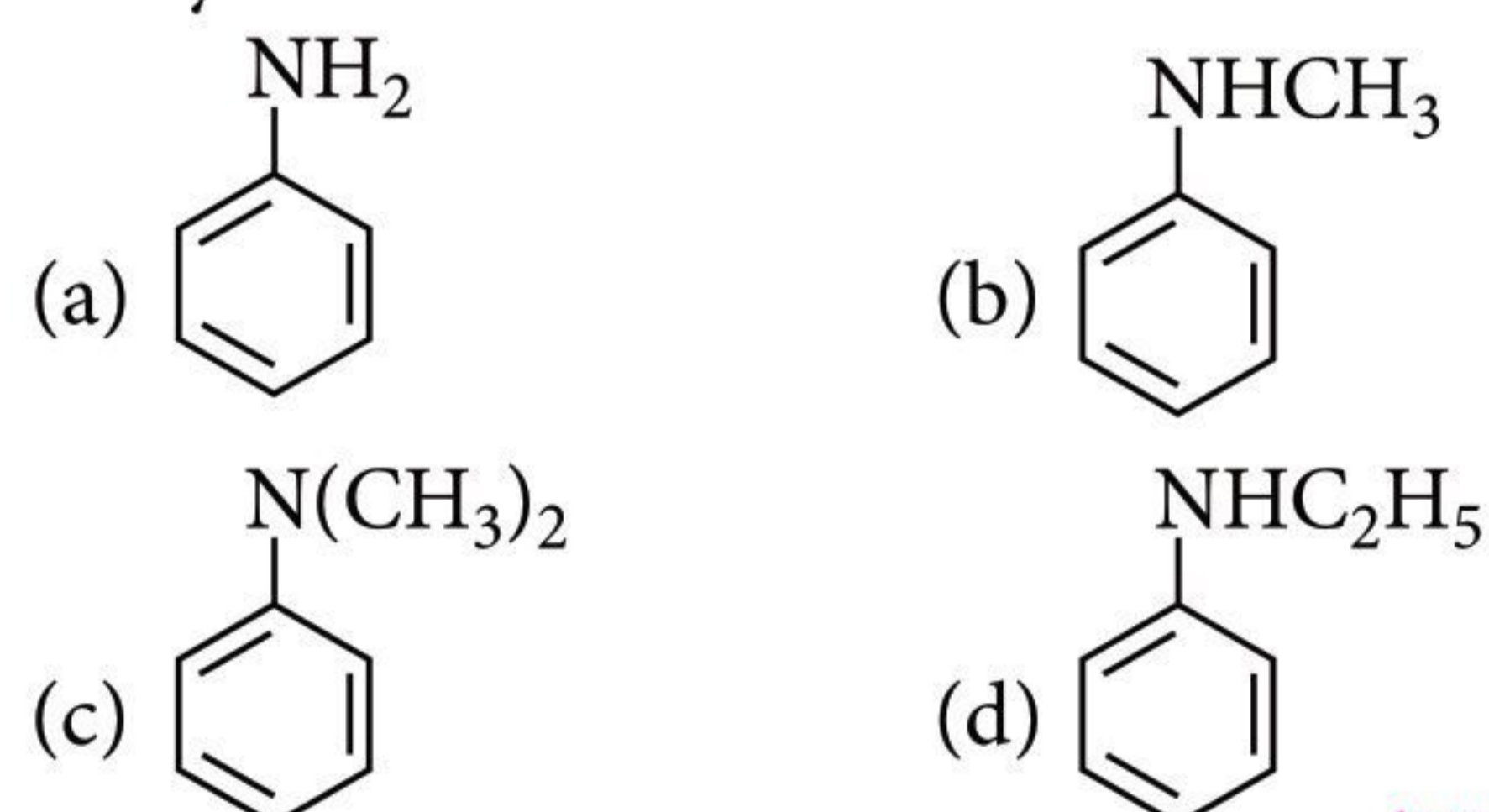
Statement 1 : H_3N^+ --F is more acidic than H_3N^+ -.

Statement 2 : H_3N^+ --F is more acidic due to the inductive effect.

Choose the correct option.

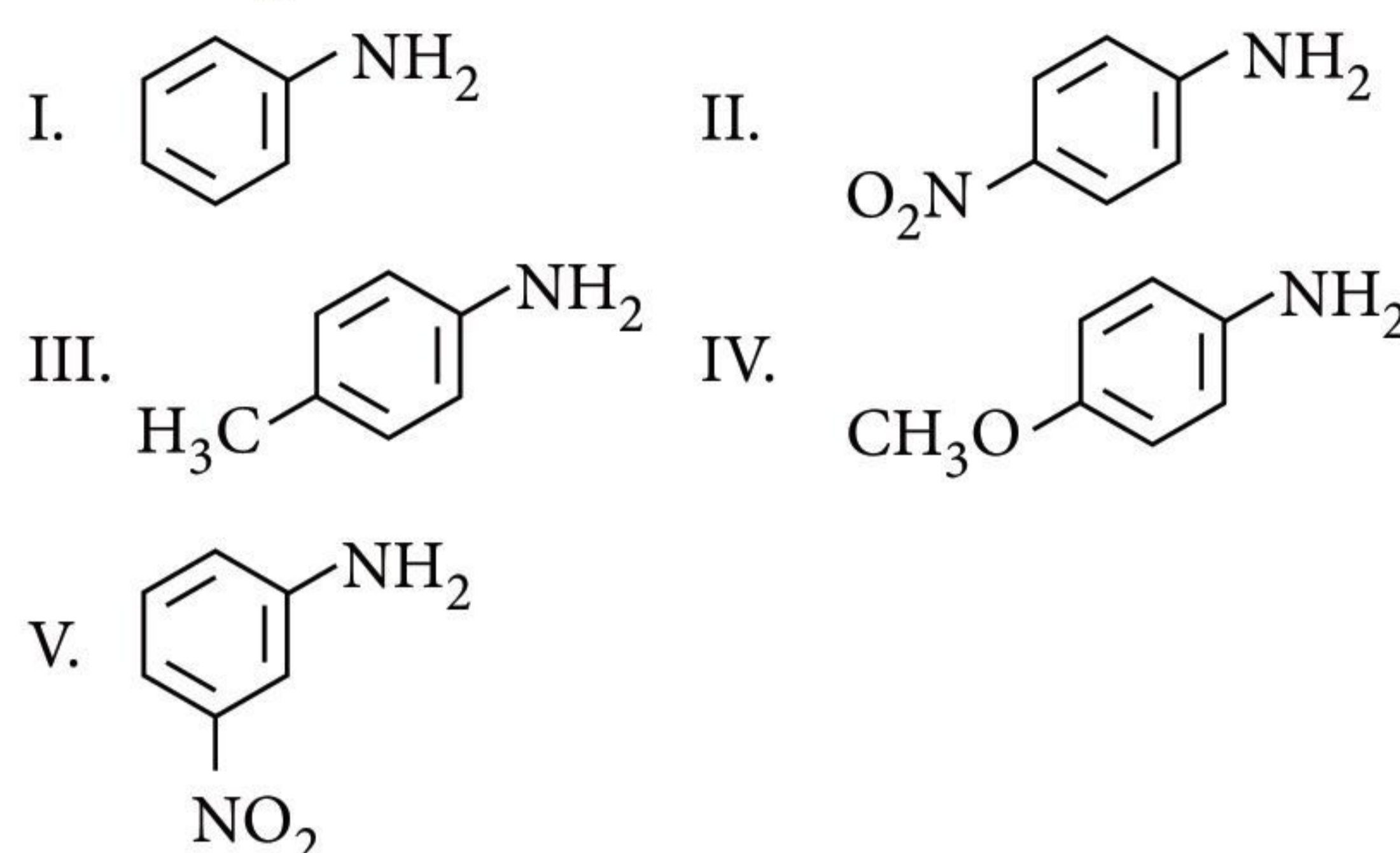
- (a) Statement-1 is false but statement-2 is true.
(b) Both statement 1 and statement-2 are true and statement 2 is the correct reason of statement 1.
(c) Statement-1 is true but statement-2 is false.
(d) Both statement 1 and statement-2 are false.

17. Which of the following amines will give the carbylamine test?



(NEET 2020)

18. The correct order of increasing basic nature of the following bases is



- (a) $\text{II} < \text{V} < \text{I} < \text{III} < \text{IV}$ (b) $\text{V} < \text{II} < \text{I} < \text{III} < \text{IV}$
(c) $\text{II} < \text{V} < \text{I} < \text{IV} < \text{III}$ (d) $\text{V} < \text{II} < \text{I} < \text{IV} < \text{III}$

19. Given below are two statements :

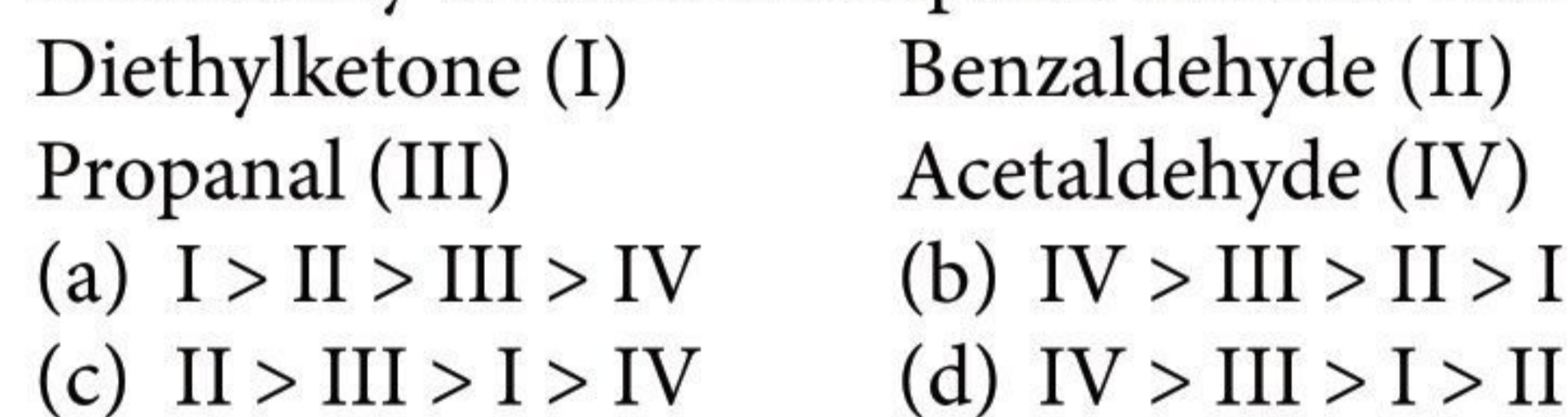
Statement 1 : On nitration, benzoic acid forms *o*- and *p*-nitrobenzene.

Statement 2 : In benzoic acid, the COOH group is *ortho*- and *para*-directing.

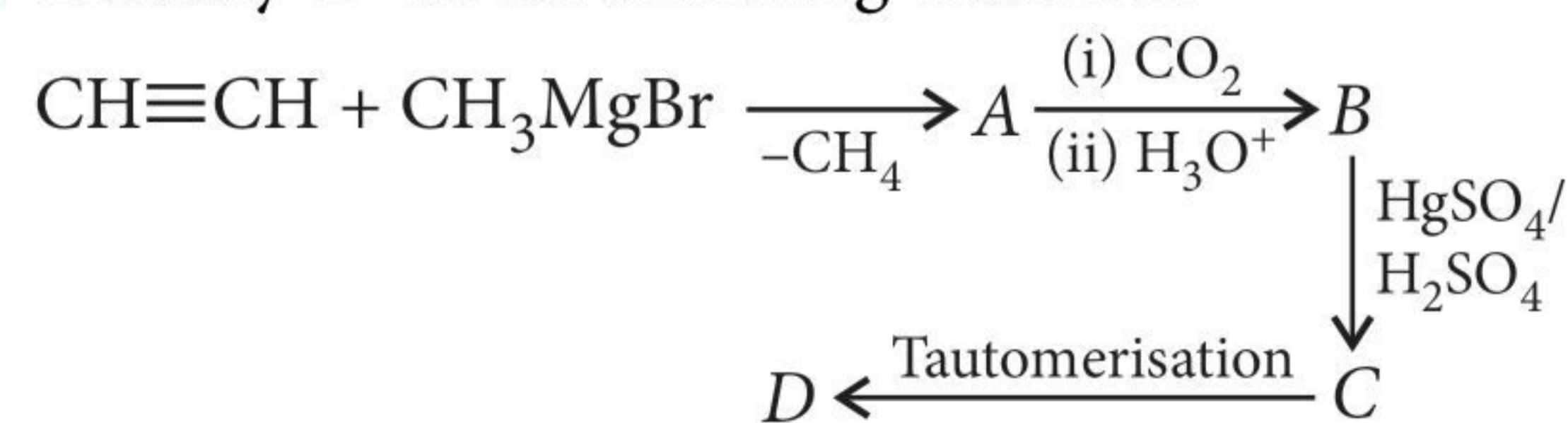
Choose the correct option.

- (a) Statement 1 is false but statement 2 is true.
(b) Both statement 1 and statement 2 are true and statement 2 is the correct reason of statement 1.
(c) Statement 1 is true but statement 2 is false.
(d) Both statement 1 and statement 2 are false.

20. Arrange the following compounds in decreasing order of reactivity towards nucleophilic addition reactions.

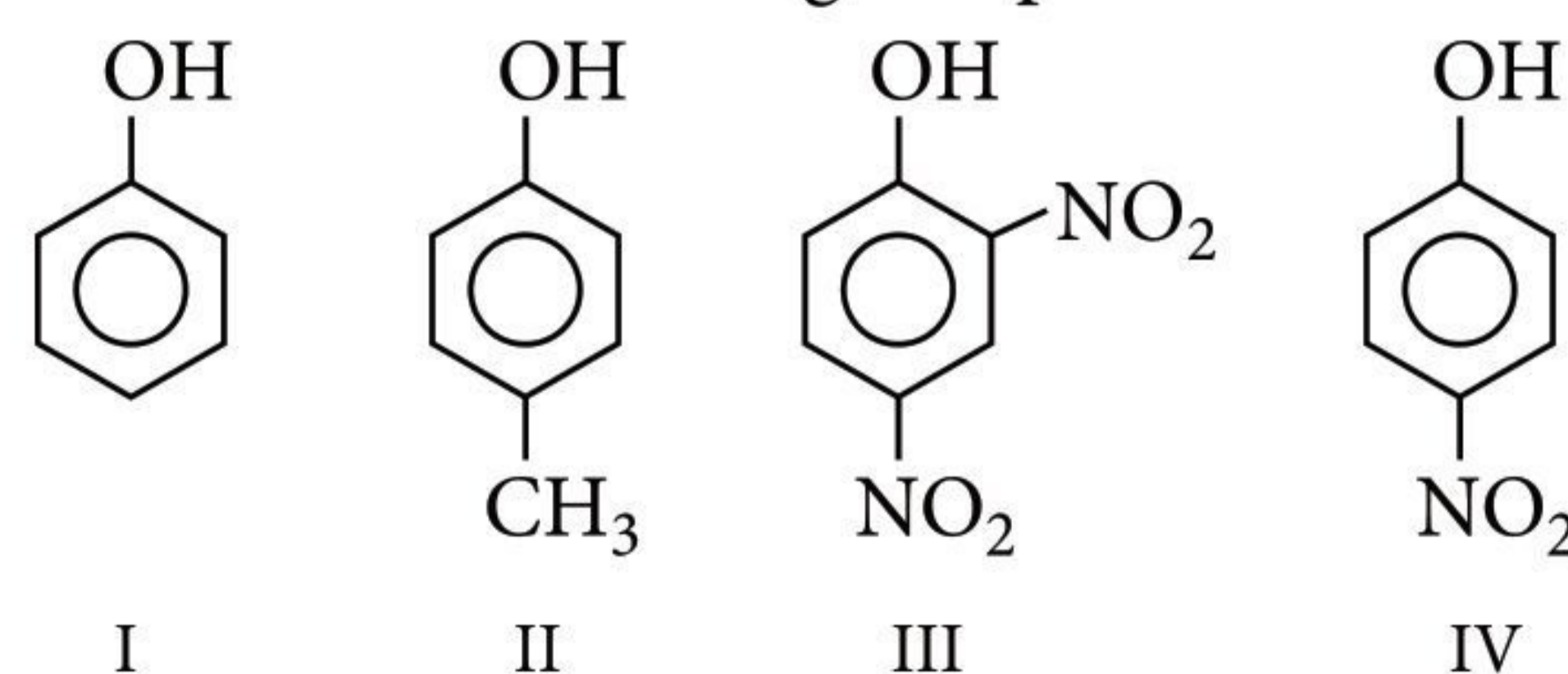


21. Identify 'D' in the following reaction :



- (a) $\text{HOOC}-\text{CH}_2-\text{COOH}$
(b) $\text{OHC}-\text{CH}_2-\text{COOH}$
(c) $\text{OHC}-\text{CH}_2-\text{CHO}$
(d) $\text{HO}-\text{CH}=\text{CH}-\text{COOH}$

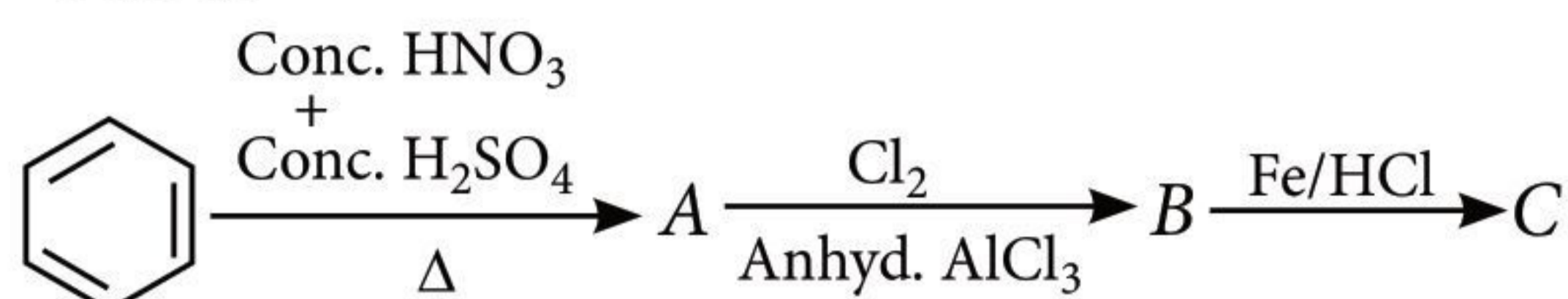
22. Consider the following compounds.



The order of decreasing acidity is

- (a) $\text{II} > \text{I} > \text{III} > \text{IV}$ (b) $\text{III} > \text{IV} > \text{I} > \text{II}$
 (c) $\text{I} > \text{IV} > \text{III} > \text{II}$ (d) $\text{IV} > \text{III} > \text{I} > \text{II}$

23. Identify A, B and C in the reaction sequence given below.



- (a) $\text{A} = \text{C}_6\text{H}_5\text{NO}_2$, $\text{B} = \text{m-Cl-C}_6\text{H}_4\text{NO}_2$, $\text{C} = \text{p-Cl-C}_6\text{H}_4\text{OH}$
 (b) $\text{A} = \text{C}_6\text{H}_5\text{NO}_2$, $\text{B} = \text{m-Cl-C}_6\text{H}_4\text{NO}_2$, $\text{C} = \text{p-Cl-C}_6\text{H}_4\text{NH}_2$
 (c) $\text{A} = \text{C}_6\text{H}_5\text{NO}_2$, $\text{B} = \text{m-Cl-C}_6\text{H}_4\text{NO}_2$, $\text{C} = \text{p-Cl-C}_6\text{H}_4\text{NH}_2$
 (d) $\text{A} = \text{C}_6\text{H}_5\text{NO}_2$, $\text{B} = \text{m-Cl-C}_6\text{H}_4\text{NO}_2$, $\text{C} = \text{p-Cl-C}_6\text{H}_4\text{NH}_2$

(JEE Main 2021)

24. Organic compound $\text{C}_3\text{H}_9\text{N}$ (A) when treated with nitrous acid gave an alcohol and N_2 gas was evolved. (A) on warming with CHCl_3 and caustic potash gave (B) which on reduction gave isopropyl methyl amine. Predict the structure of (A).

- (a) $\text{CH}_3\text{—CH}_2\text{—CH}_2\text{—NH}_2$
 (b) $\text{CH}_3\text{—CH(CH}_3\text{)—NH}_2$
 (c) $\text{CH}_3\text{—CH}_2\text{—NH—CH}_3$
 (d) $\text{CH}_3\text{—N(CH}_3\text{)—CH}_3$

25. Carboxylic acids, $\text{CH}_3\text{—C(=O)—OH}$ though apparently contain a carbonyl group $\left(\text{—C(=O)—}\right)$ but do not give

addition and condensation reactions of aldehydes and ketones because

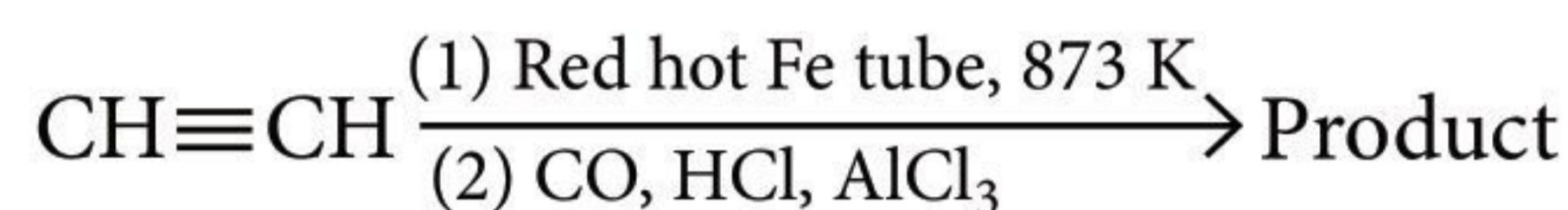
- (a) carboxylate ion is resonance stabilised
 (b) acids do not contain a potential aldehyde group
 (c) contributing resonance structures of carboxylic acids and carboxylate ions (conjugate bases)

reveal that there is no real (potential) carbonyl group

- (d) none of these.

NUMERICAL VALUE TYPE

26. Consider the following chemical reaction :

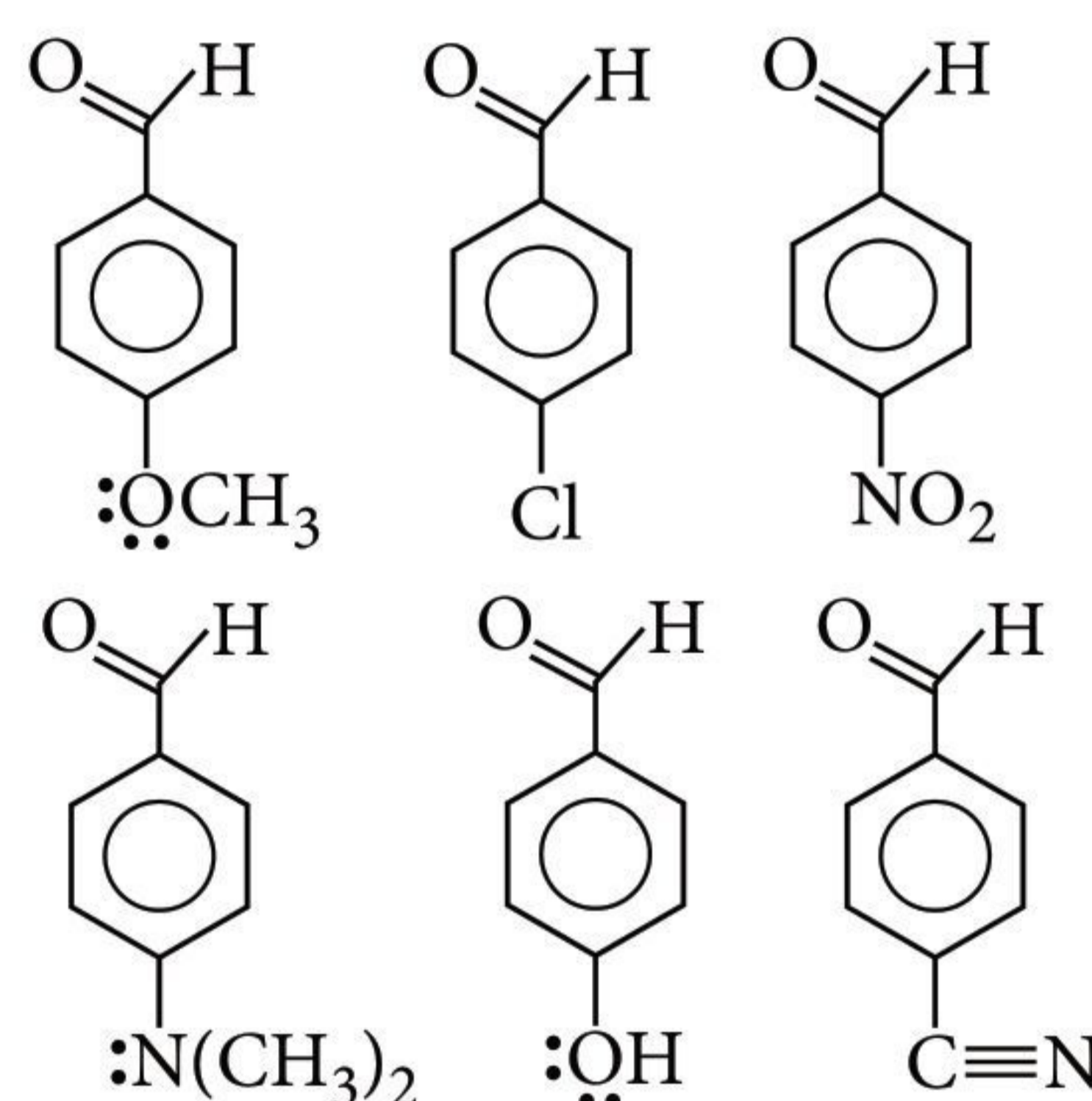
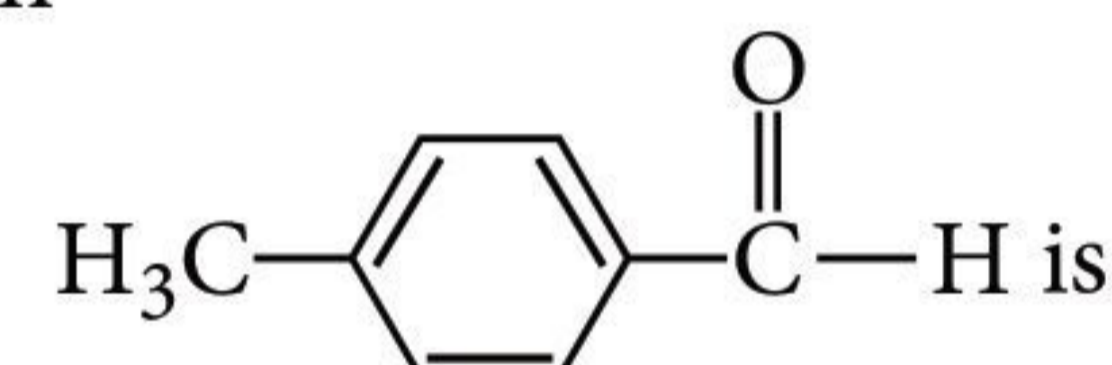


The number of sp^2 -hybridized carbon atom(s) present in the product is _____.

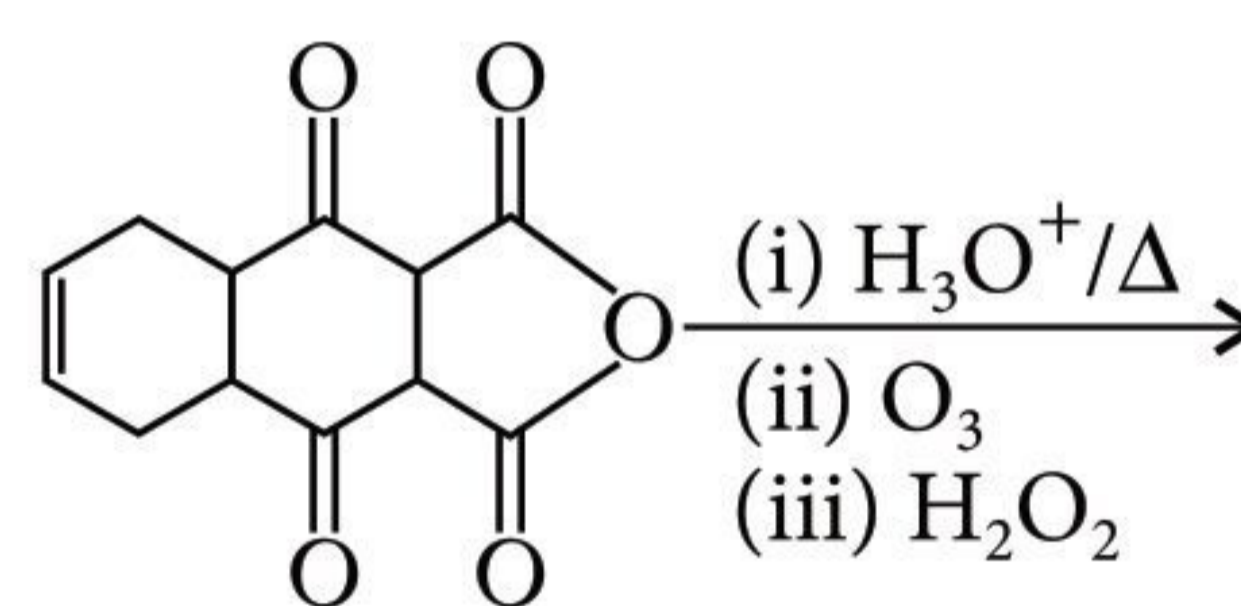
(JEE Main 2021)

27. The minimum number of nitrogen atoms that must be present in the compound whose one molecule contains 7 carbon atoms, 1 chlorine atom and 7 hydrogen atoms is _____.

28. From the following compounds, the number of compounds which show(s) higher rate of nucleophilic addition than



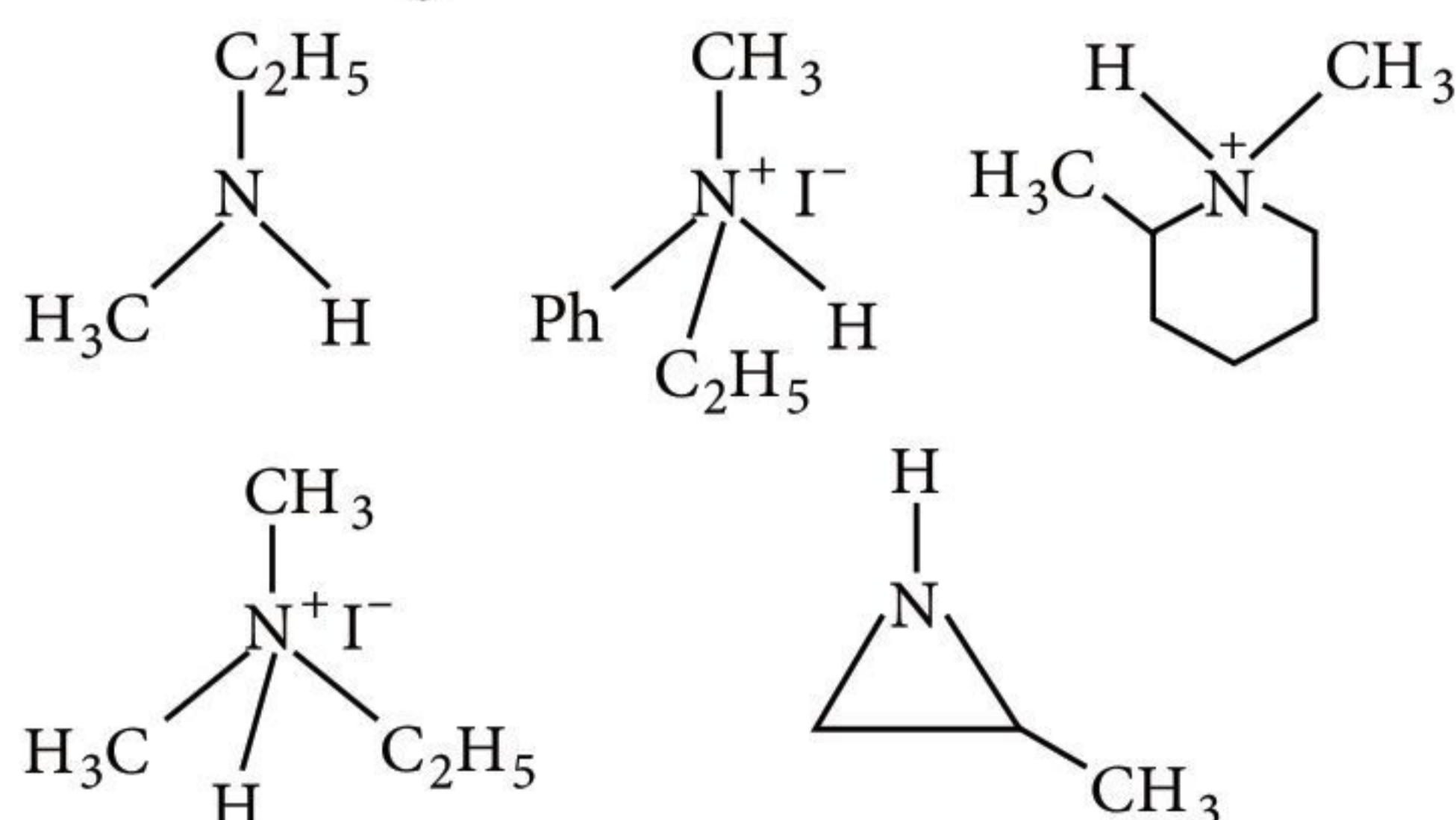
29. In the given reaction, the total number of carboxylic groups in the product is _____.



MONTHLY TEST DRIVE CLASS XII ANSWER KEY

- | | | | | |
|---------------|------------|---------------|---------|------------|
| 1. (a) | 2. (d) | 3. (b) | 4. (a) | 5. (b) |
| 6. (d) | 7. (b) | 8. (b) | 9. (b) | 10. (d) |
| 11. (d) | 12. (b) | 13. (a) | 14. (a) | 15. (d) |
| 16. (b) | 17. (b) | 18. (d) | 19. (b) | 20. (b, c) |
| 21. (a, b, c) | 22. (a, b) | 23. (a, c, d) | 24. (6) | 25. (4) |
| 26. (0) | 27. (d) | 28. (b) | 29. (d) | 30. (a) |

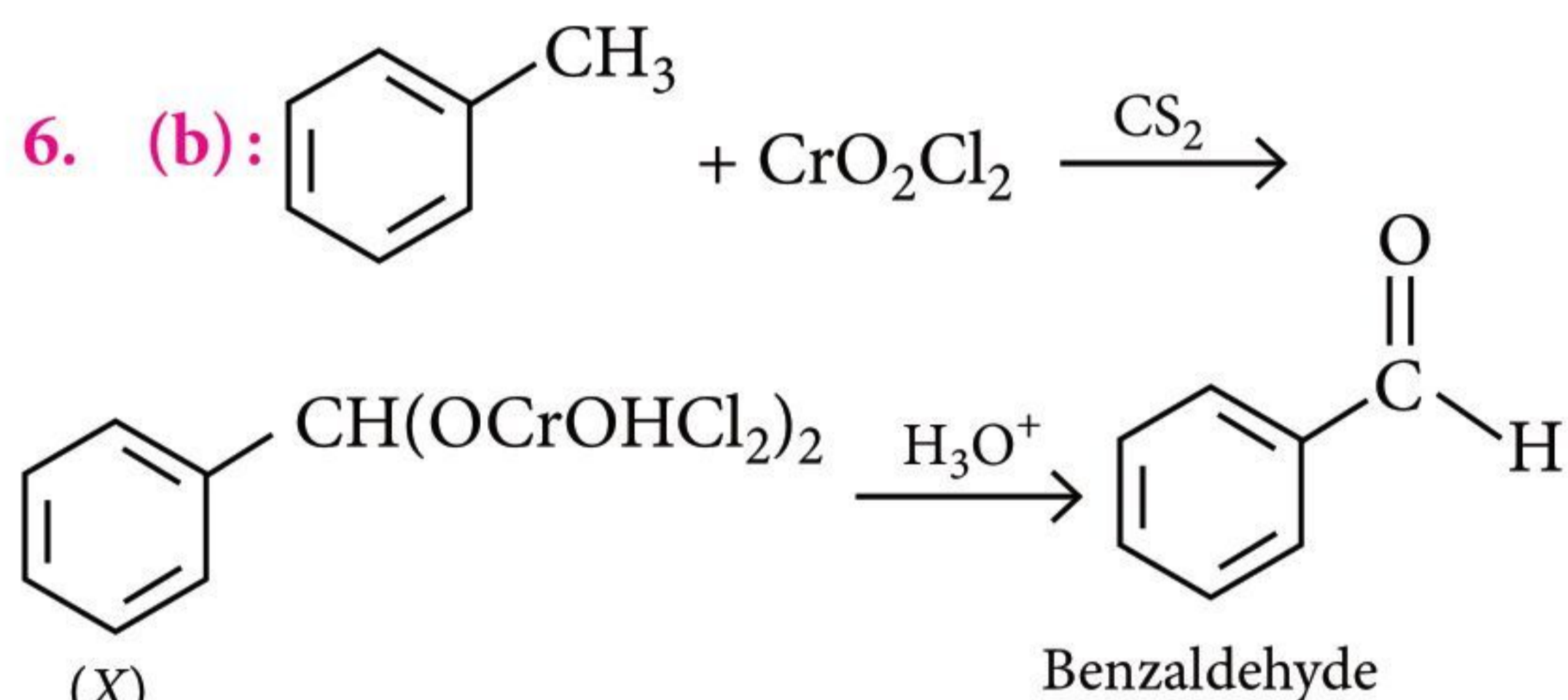
30. Total number of optically active compounds from the following list is _____.



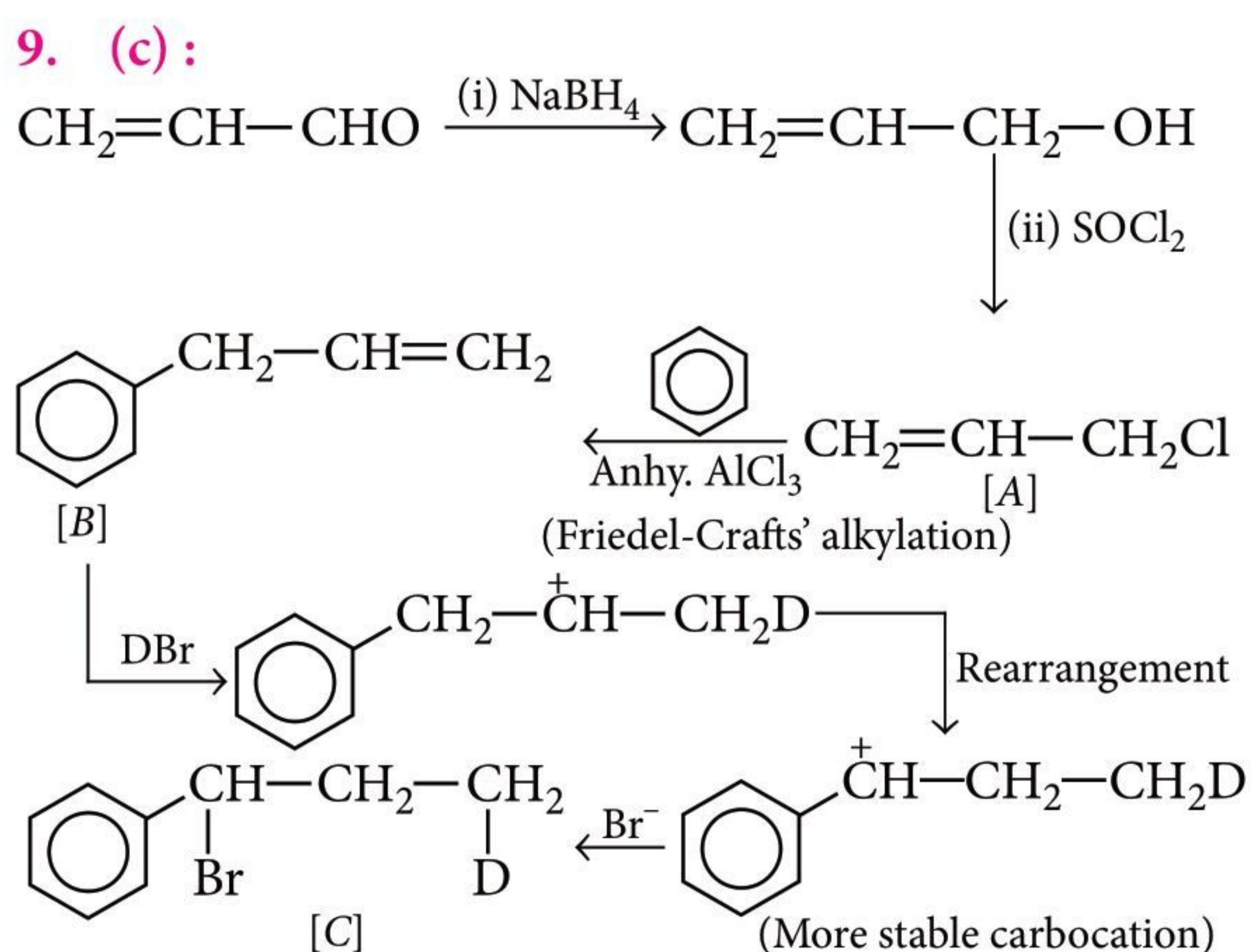
SOLUTIONS

1. (b)
 2. (b): Due to $-I$ -effect of F, electron density in the N—H bond decreases and hence release of a proton becomes easier from *p*-fluoroanilinium ion than that from anilinium ion. All other statements are correct.
 3. (b): Less stable the diazonium salt more reactive it will be. Since the stability decreases in the order : I > III > IV > II, therefore, reactivity increases in the reverse order, i.e., I < III < IV < II.

4. (b) 5. (c)

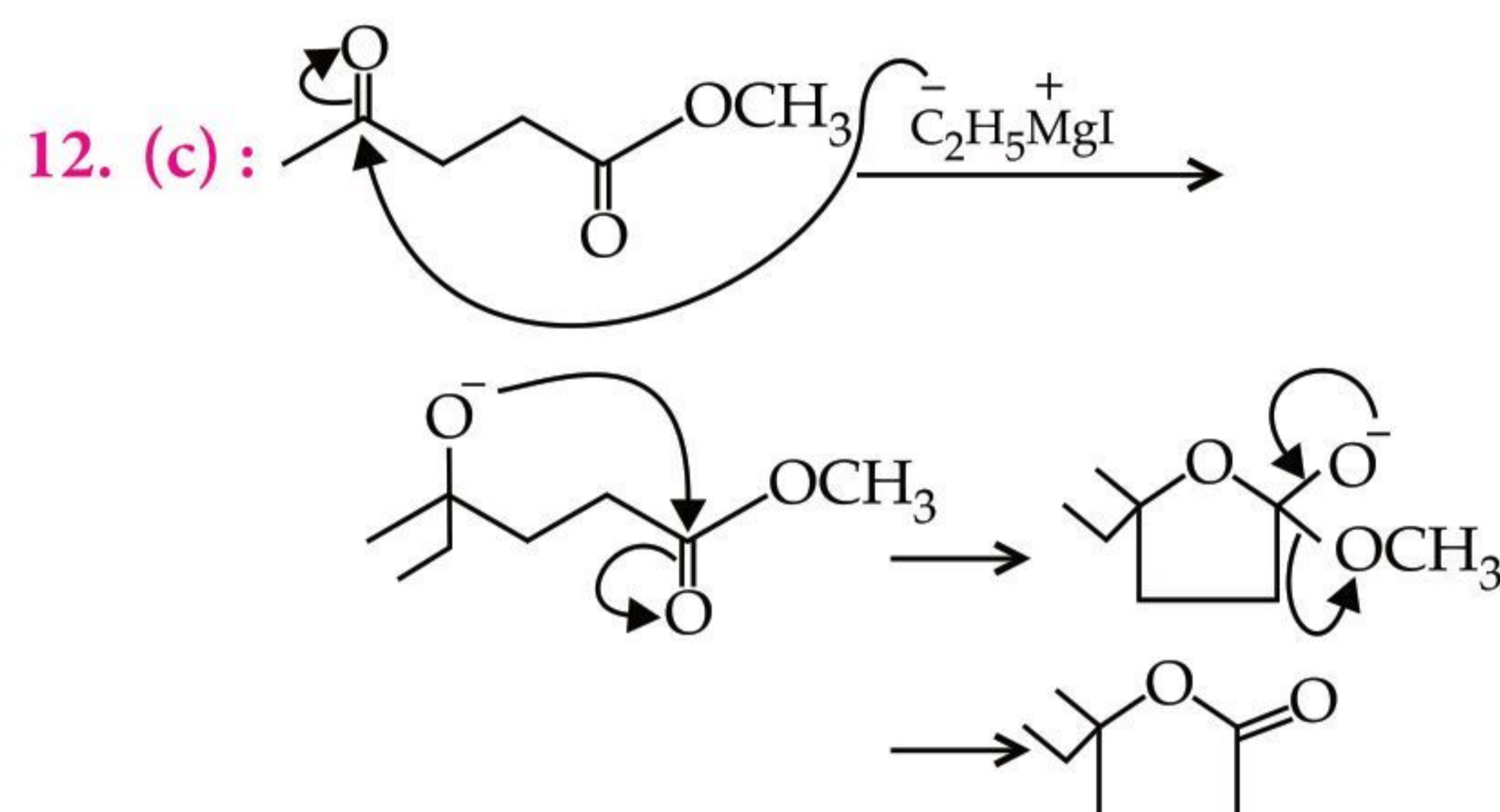
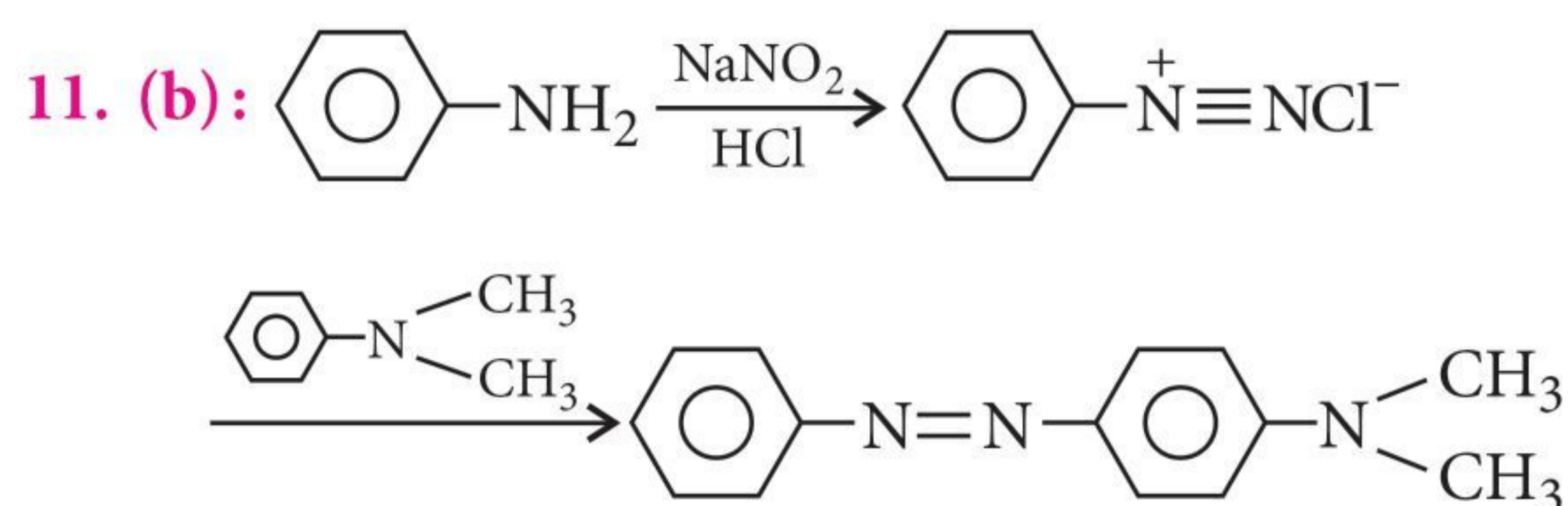


7. (a) 8. (c)



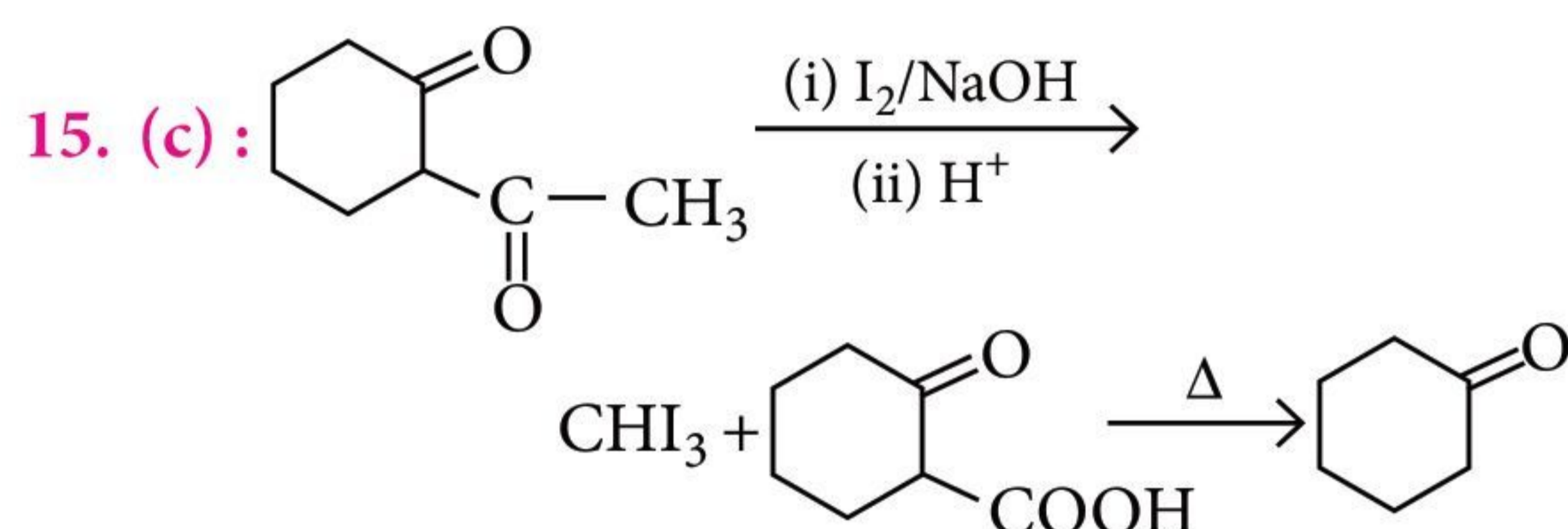
10. (b): 'X' is formed by Etard reaction

and 'Y' is $\text{C}_6\text{H}_5-\text{C}(=\text{O})-\text{O}-\text{CH}_2-\text{C}_6\text{H}_5$ formed by Tischenko reaction.



13. (b)

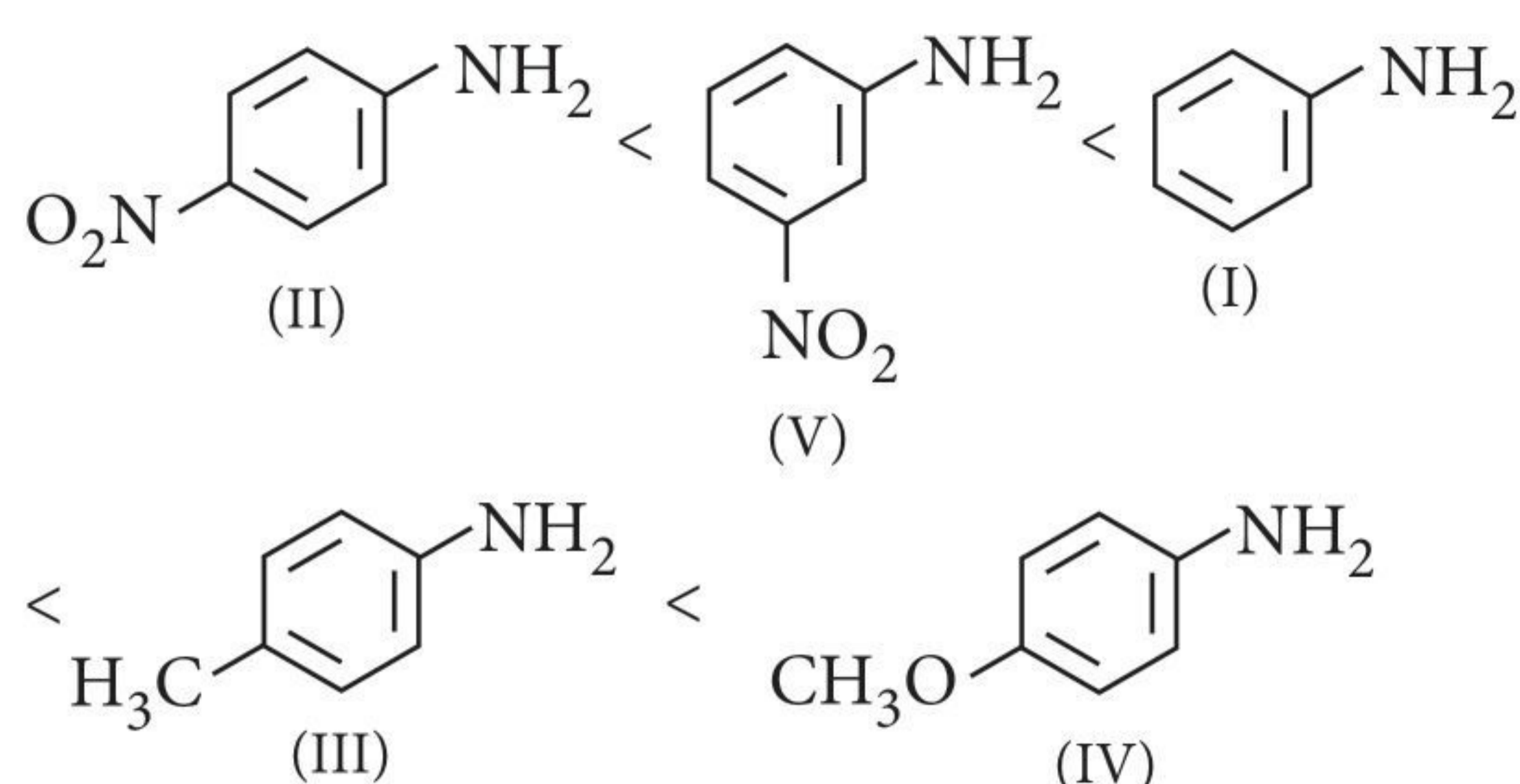
14. (d): As it gives positive iodoform test hence it should have $\text{CH}_3-\text{C}(=\text{O})-$ group and it also gives isopentane on reduction so it can be 3-methyl butan-2-one.



16. (b)

17. (a): Aliphatic and aromatic primary amines give carbylamine test. Secondary and tertiary amines do not show this reaction.

18. (a): $-\text{OCH}_3$ is strongest electron releasing group ($+M$ effect) which opposes most the dispersion of lone pair of electrons of nitrogen into the ring. Thus, $-\text{OCH}_3$ being at *para* position imparts highest basicity. $-\text{NO}_2$ being at *meta* position stabilises the electron pair of nitrogen only by $-I$ effect. While $-\text{NO}_2$ being present at *para* position due to $-M$ effect and $-I$ effect stabilises the lone pair of electrons of nitrogen most and imparts least basicity.

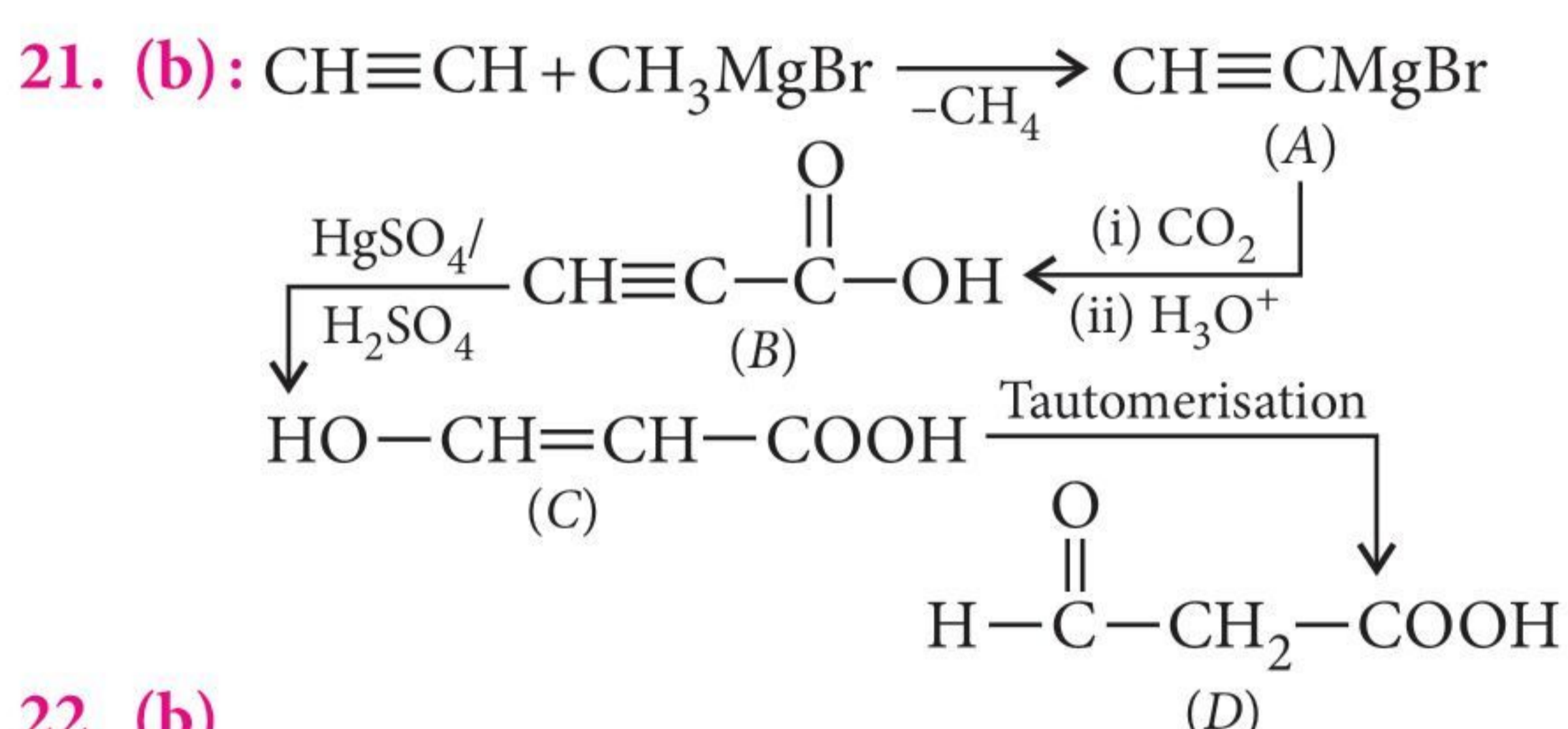
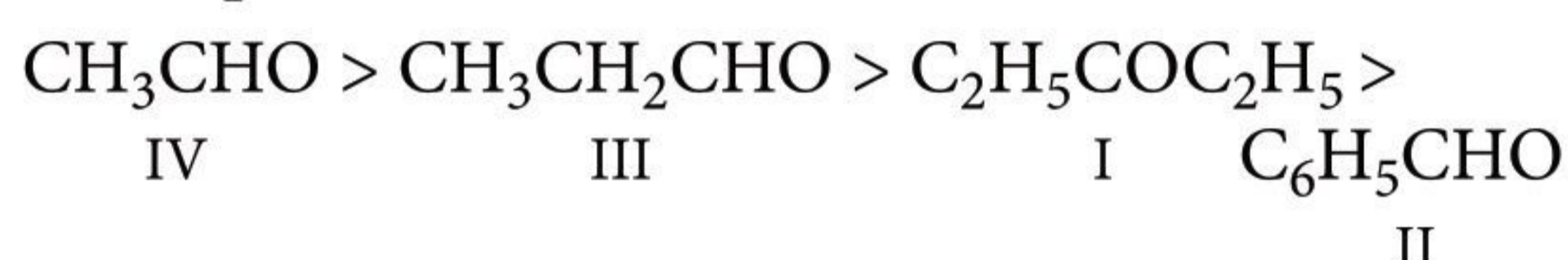


19. (d)

20. (d): Ketones are less reactive than aldehydes due to the presence of two large electron releasing alkyl groups, which hinder the attack of nucleophile on the carbonyl carbon and also reduces the electrophilicity of the carbonyl carbon.

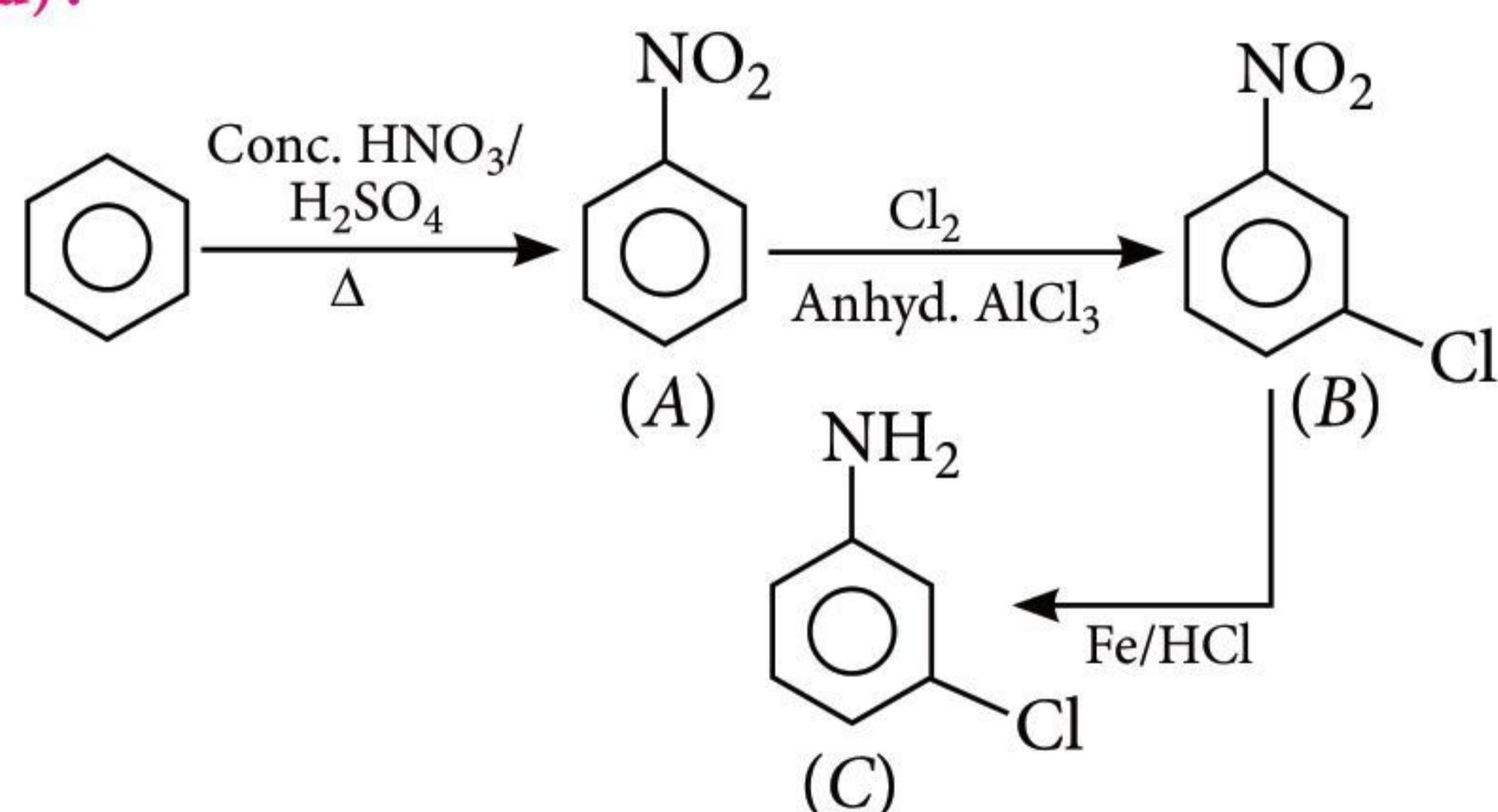
As the size of the alkyl group increases, +I effect increases and thus reactivity decreases. Aromatic aldehydes and ketones are less reactive due to +R effect of the benzene ring.

Thus, the decreasing order of reactivity towards nucleophilic addition reaction is :



22. (b)

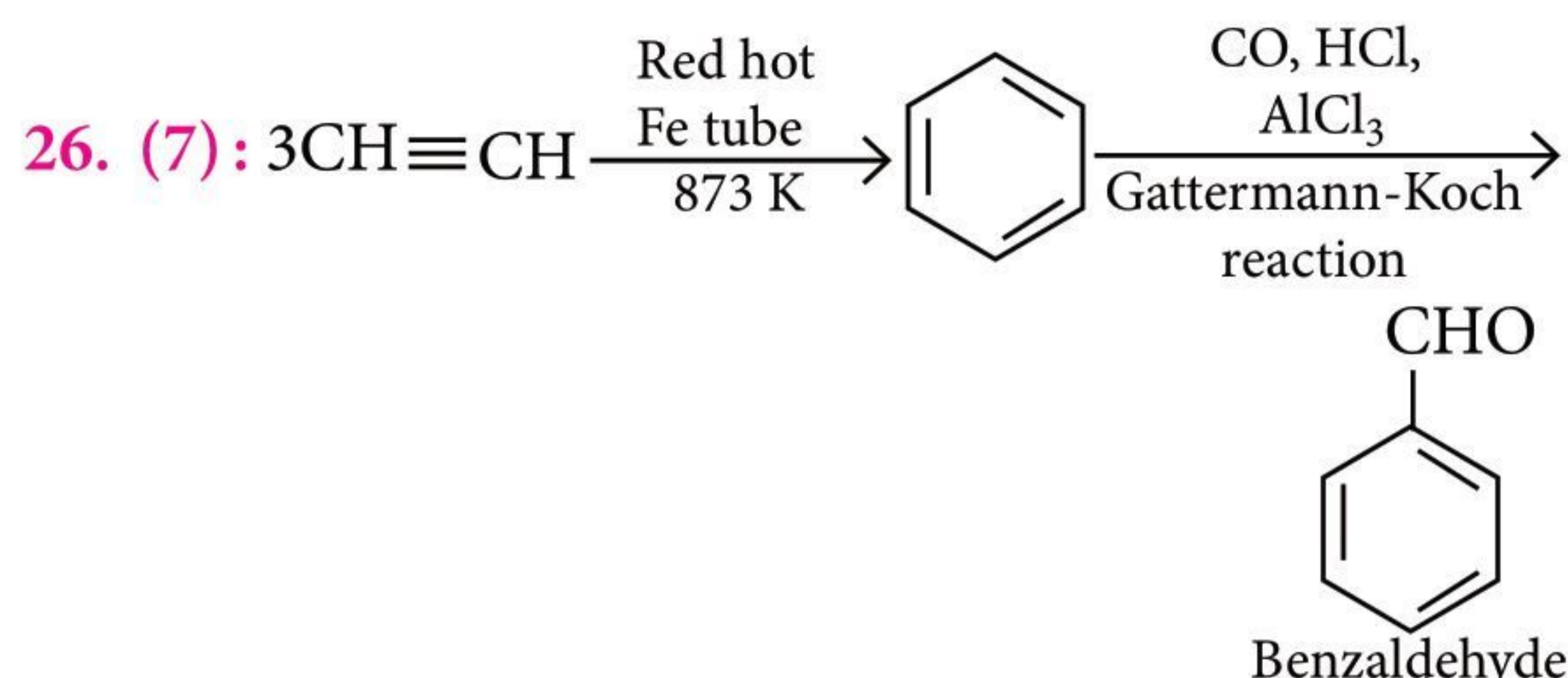
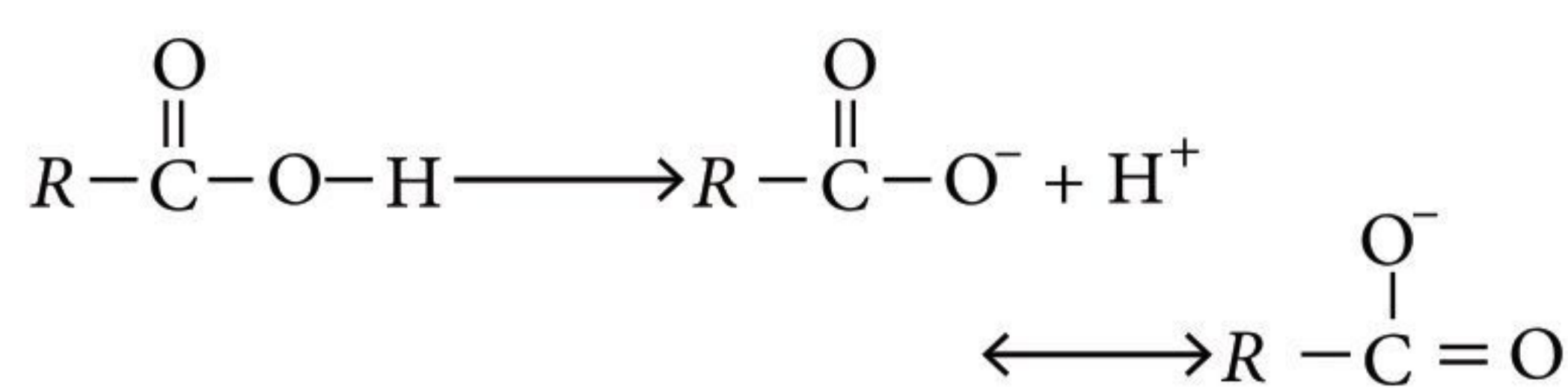
23. (d):



24. (b)

25. (c): In resonance structures of carboxylic acid and carboxylate ion the real carbonyl group is absent.

Therefore, $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{OH}$ do not give addition and condensation reactions like aldehyde and ketones.



All carbon atoms in benzaldehyde are sp^2 -hybridised.

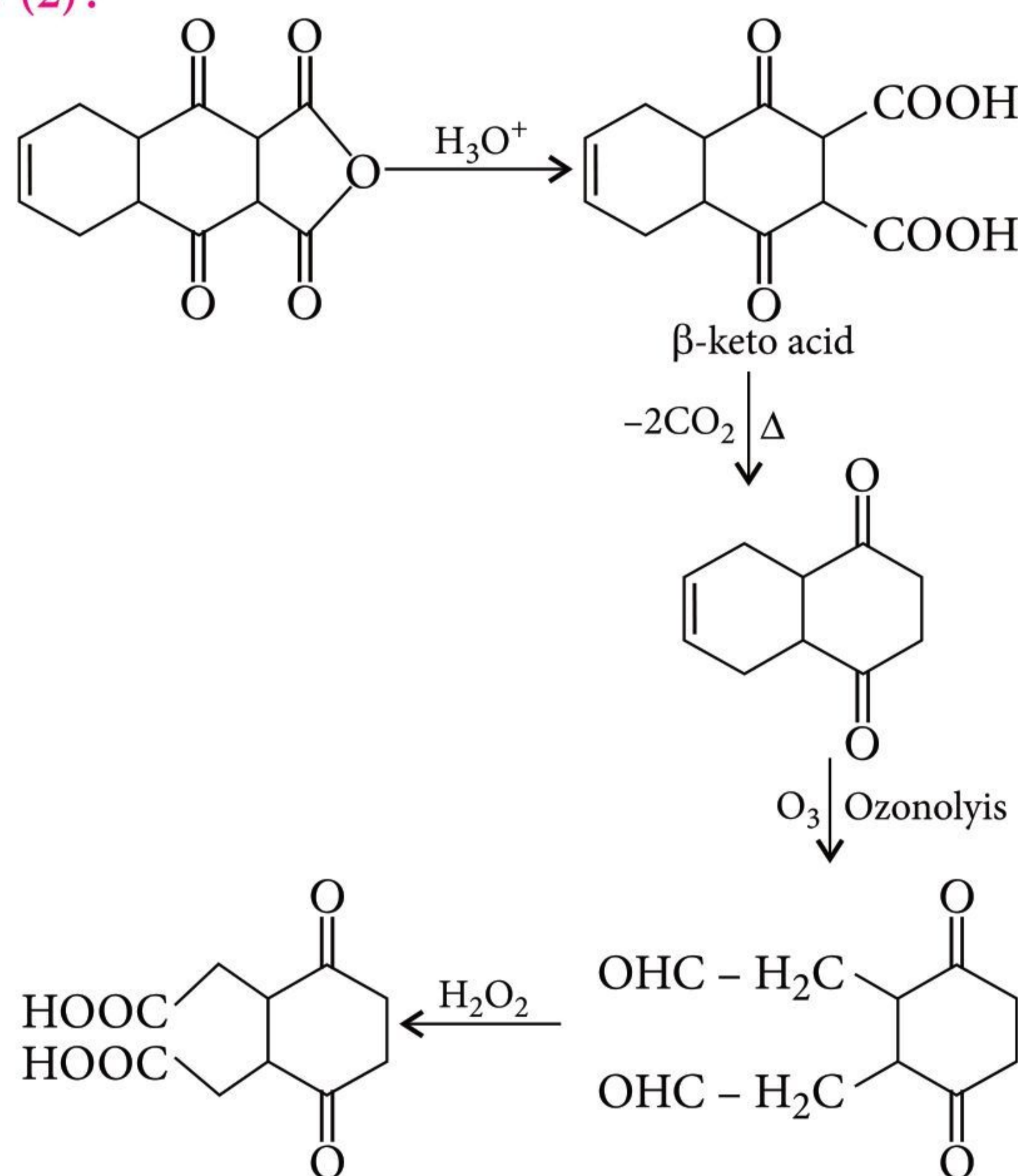
27. (2): $\text{DBE} = \frac{2C + 2 + N - H - X}{2}$

Given = $\frac{2 \times 7 + 2 + \boxed{?} - 7 - 1}{2}$

For DBE to be a whole number, minimum no. of nitrogen atoms must be 2.

28. (3)

29. (2):



30. (3): The first compound is optically inactive due to pyramidal inversion but the last ring compound is active, being a small sized ring, pyramidal inversion is prevented there. Second and third are also active. The fourth compound carries identical groups, hence, inactive.



CBSE TERM-I

Held on
14th Dec

SOLVED PAPER 2021

CLASS
12

We are happy to inform our readers that out of the 55 questions asked in CBSE Board Term-I Exam, 2021 more than 90% questions were either exactly same or of similar type from the **MTG 100 PERCENT Exam Ready Term-I, Chemistry Class-12**

The references of few questions of paper having code : 056/3/4 are given here :

Exam Q. No.	MTG Book	Q. No.	P. No.
1	Exam Ready Term-I	76	30
2	Exam Ready Term-I	13	6
4	Exam Ready Term-I	22	83
6	Exam Ready Term-I	45	103
18	Exam Ready Term-I	25	46
19	Exam Ready Term-I	2	44
21	Exam Ready Term-I	76	50
27	Exam Ready Term-I	29	102
28	Exam Ready Term-I	23	83
30	Exam Ready Term-I	56	48

Exam Q. No.	MTG Book	Q. No.	P. No.
32	Exam Ready Term-I	51	10
35	Exam Ready Term-I	72	30
40	Exam Ready Term-I	16	101
42	Exam Ready Term-I	28	46
43	Exam Ready Term-I	60	66
46	Exam Ready Term-I	82	51
47	Exam Ready Term-I	56	65
48	Exam Ready Term-I	94	14
54	Exam Ready Term-I	12	82
55	Exam Ready Term-I	85	88

and more such questions.....

General Instructions : Read the following instructions carefully.

- (a) This question paper contains 55 questions out of which 45 questions are to be attempted.
- (b) All questions carry equal marks.
- (c) This question paper consists of three sections - Section A, B and C.
- (d) Section-A contains 25 questions. Attempt any 20 questions from Q. No. 1 to 25.
- (e) Section-B contains 24 questions. Attempt any 20 questions from Q. No. 26 to 49.
- (f) Section-C contains 6 questions. Attempt any 5 questions from Q. No. 50 to 55.
- (g) The first 20 questions attempted in Section A and Section B and first 5 questions attempted in Section C by a candidate will be evaluated.
- (h) There is only one correct option for every multiple choice question (MCQ). Marks will not be awarded for answering more than one option.
- (i) There is no negative marking.

Time Allowed : 90 minutes
Maximum Marks : 35

SECTION-A

This section consists of 25 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

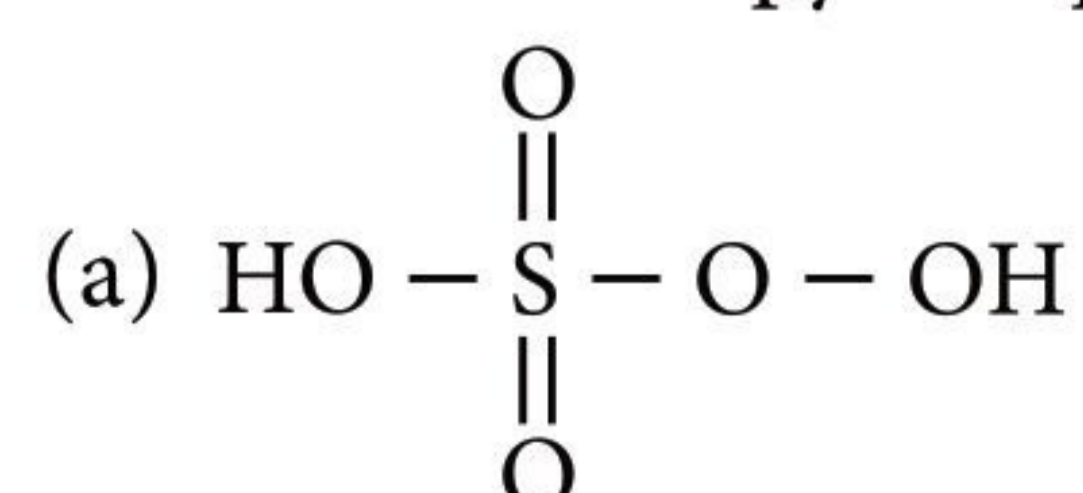
1. Which one of the following pairs will form an ideal solution?
- (a) Chloroform and acetone
 - (b) Ethanol and acetone

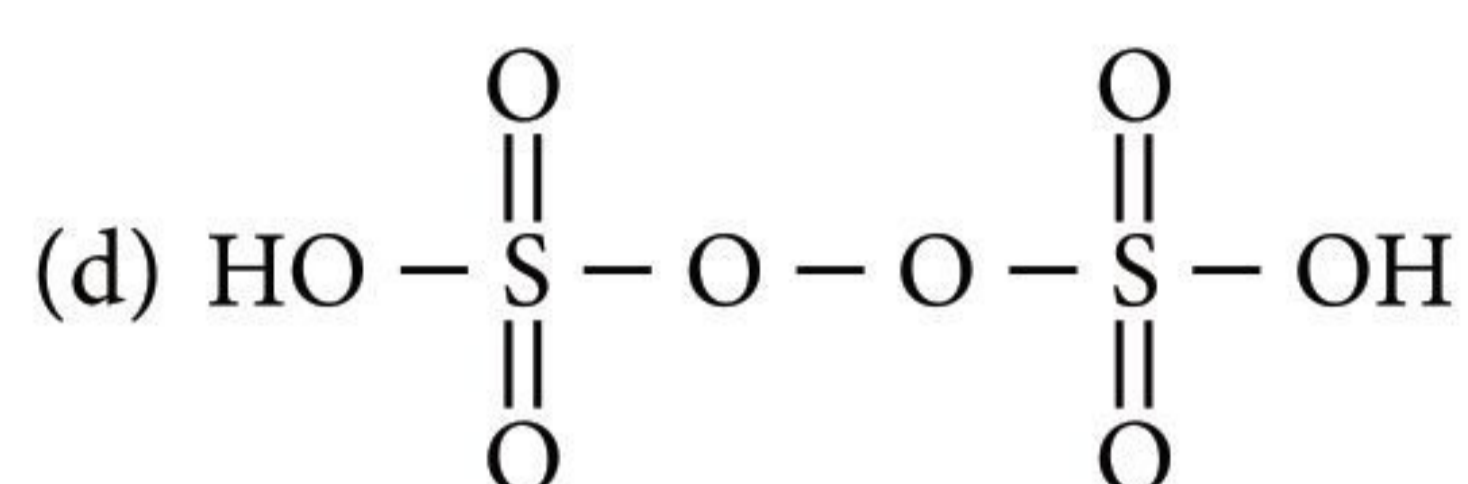
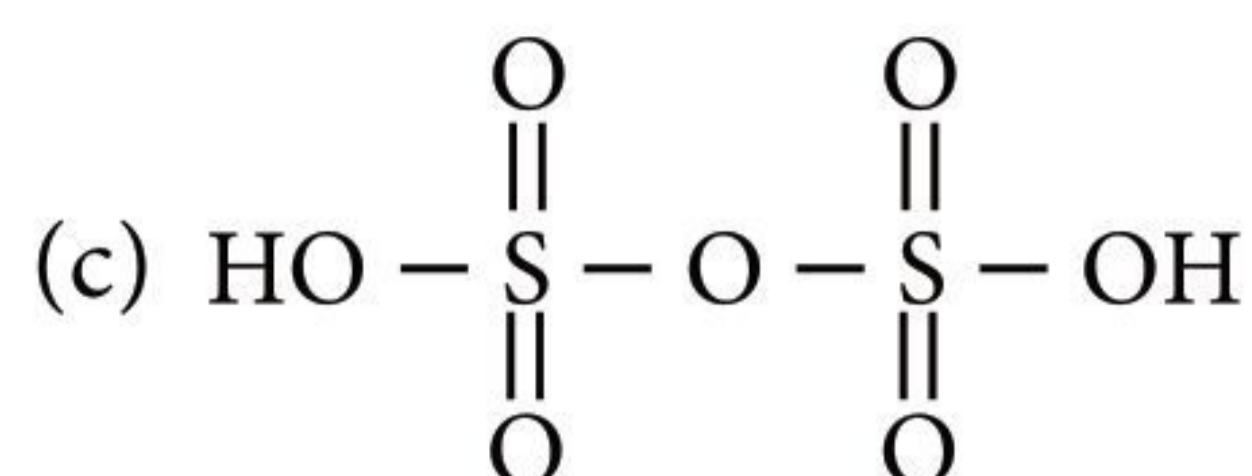
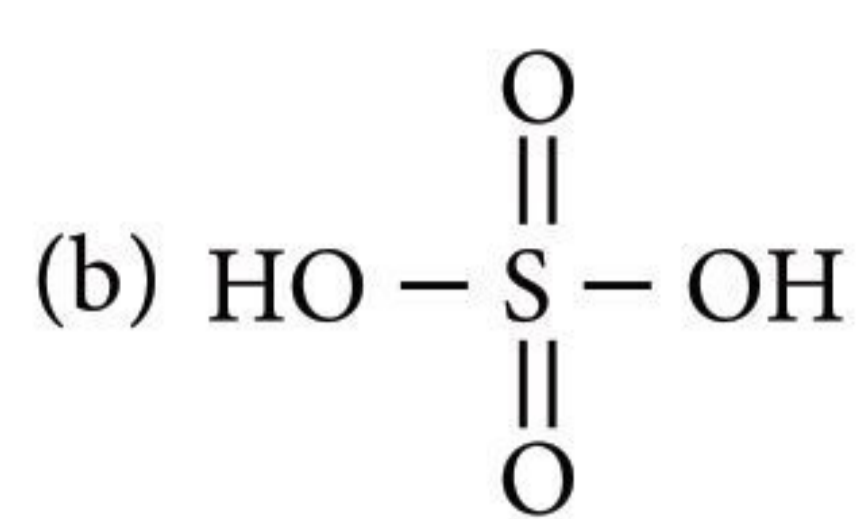
- (c) *n*-Hexane and *n*-heptane
- (d) Phenol and aniline

2. Which of the following is known as amorphous solid?

- (a) Glass
- (b) Plastic
- (c) Rubber
- (d) All the above.

3. The structure of pyrosulphuric acid is

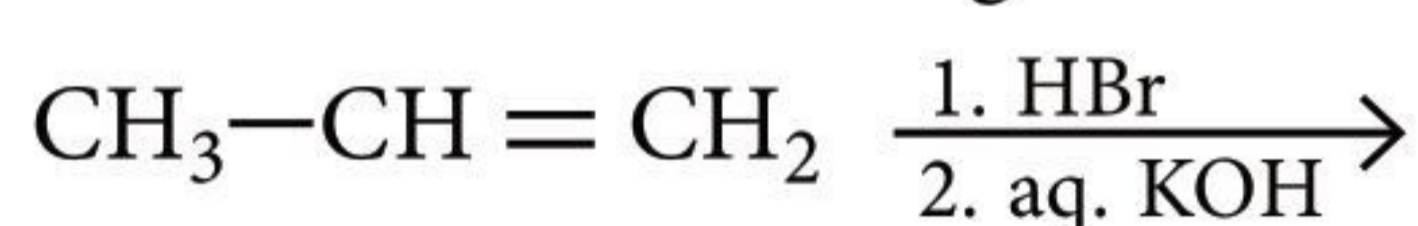




4. The C — O — H bond angle in alcohol is

- (a) slightly greater than $109^\circ 28'$
 (b) slightly less than $109^\circ 28'$
 (c) slightly greater than 120°
 (d) slightly less than 120°

5. Consider the following reaction:



The major end product is

- (a) $\text{CH}_3 - \underset{\text{OH}}{\text{CH}} - \text{CH}_3$ (b) $\text{CH}_3 - \underset{\text{Br}}{\text{CH}} - \text{CH}_3$
 (c) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{OH}$
 (d) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{Br}$

6. Nucleosides are composed of

- (a) a pentose sugar and phosphoric acid
 (b) a nitrogenous base and phosphoric acid
 (c) a nitrogenous base and a pentose sugar
 (d) a nitrogenous base, a pentose sugar and phosphoric acid.

7. The oxidation state of -2 is more stable in

- (a) O (b) S (c) Se (d) Te

8. Which of the following is not a characteristic of a crystalline solid?

- (a) A true solid.
 (b) A regular arrangement of constituent particles.
 (c) Sharp melting point.
 (d) Isotropic in nature.

9. Which of the following formula represents Raoult's law for a solution containing non-volatile solute?

- (a) $p_{\text{solute}} = p^\circ_{\text{solute}} \cdot x_{\text{solute}}$
 (b) $p = K_H \cdot x$
 (c) $P_{\text{total}} = p_{\text{solvent}}$
 (d) $p_{\text{solute}} = p^\circ_{\text{solvent}} \cdot x_{\text{solvent}}$

10. An azeotropic solution of two liquids has a boiling point lower than either of the two when it

- (a) shows a positive deviation from Raoult's law
 (b) shows a negative deviation from Raoult's law
 (c) shows no deviation from Raoult's law
 (d) is saturated.

11. Which of the following crystal will show metal excess defect due to extra cation?

- (a) AgCl (b) NaCl
 (c) FeO (d) ZnO

12. Which of the following acids reacts with acetic anhydride to form a compound aspirin?

- (a) Benzoic acid (b) Salicylic acid
 (c) Phthalic acid (d) Acetic acid

13. Which of the following statements is wrong?

- (a) Oxygen shows $p\pi - p\pi$ bonding.
 (b) Sulphur shows little tendency of catenation.
 (c) Oxygen is diatomic whereas sulphur is polyatomic.
 (d) O — O bond is stronger than S — S bond.

14. Amino acids which cannot be synthesized in the body and must be obtained through diet are known as

- (a) acidic amino acids
 (b) essential amino acids
 (c) basic amino acids
 (d) non-essential amino acids.

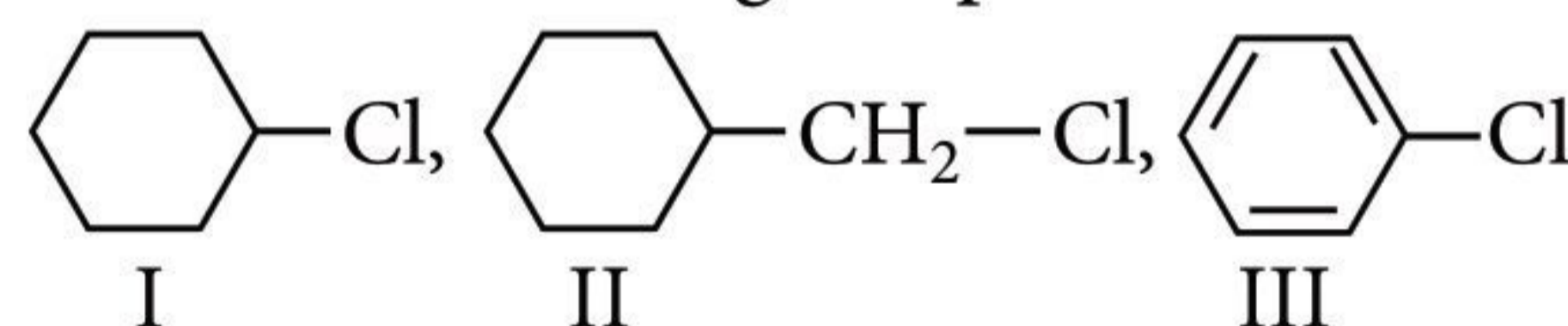
15. Which one of the following halides contains $\text{C}_{sp^2} - \text{X}$ bond?

- (a) Allyl halide (b) Alkyl halide
 (c) Benzyl halide (d) Vinyl halide

16. On mixing 20 mL of acetone with 30 mL of chloroform, the total volume of the solution is

- (a) < 50 mL (b) = 50 mL
 (c) > 50 mL (d) = 10 mL

17. Consider the following compounds



the correct order of reactivity towards $\text{S}_{\text{N}}2$ reaction

- (a) I > III > II (b) II > III > I
 (c) II > I > III (d) III > I > II

18. Which of the following forms strong $p\pi - p\pi$ bonding?

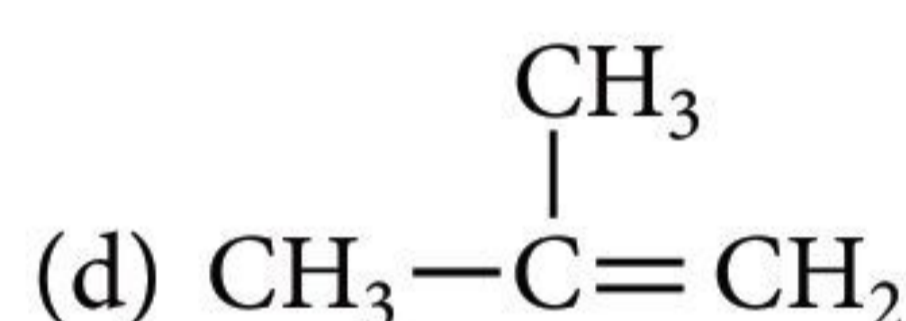
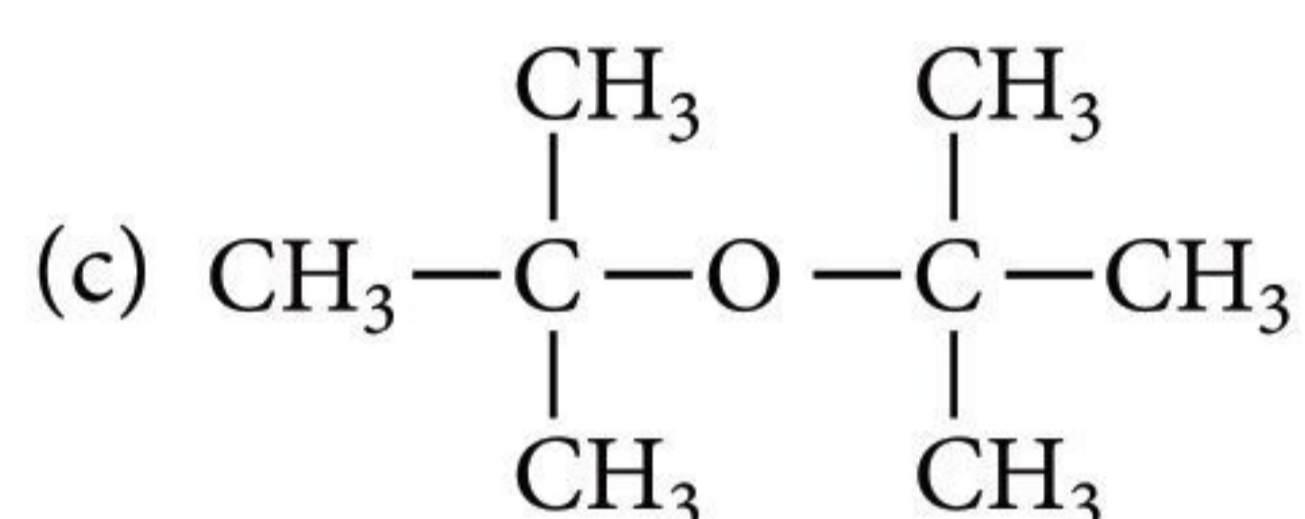
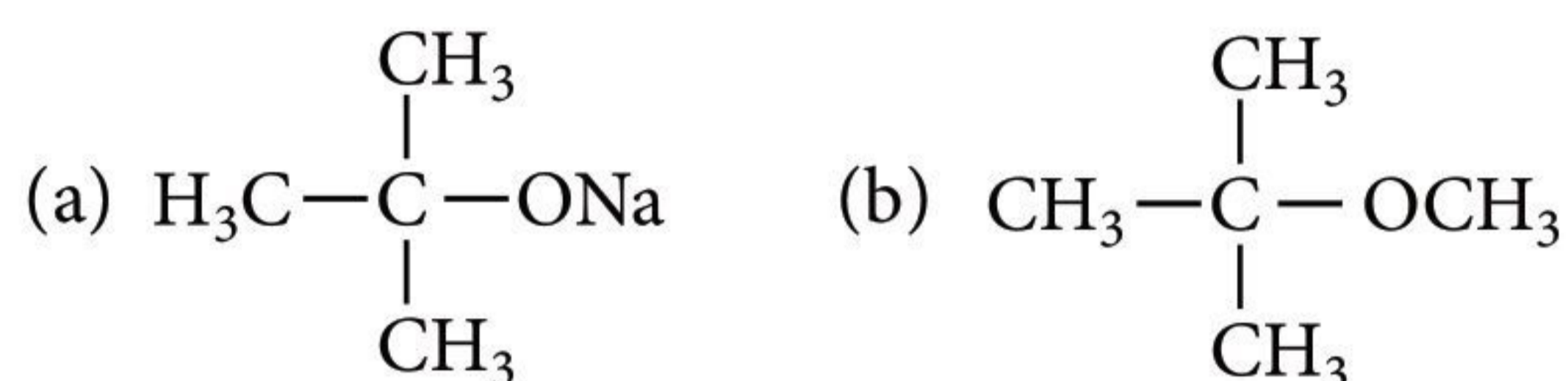
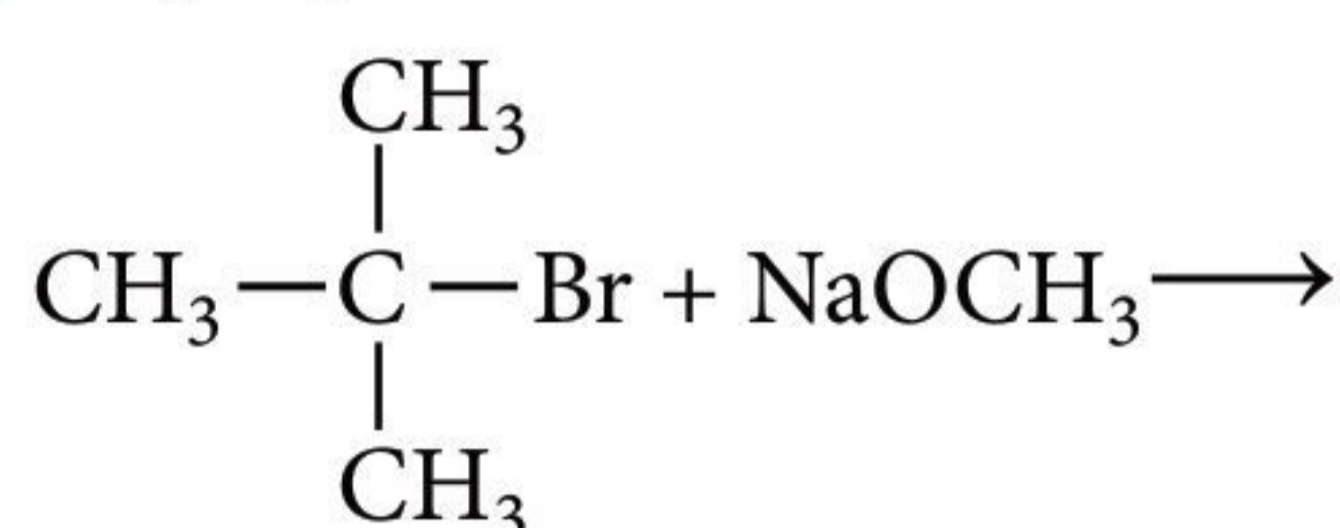
- (a) S_8 (b) Se_8 (c) Te_8 (d) O_2

19. F_2 acts as a strong oxidising agent due to

- (a) low $\Delta_{\text{bond}}H^\circ$ and low $\Delta_{\text{hyd}}H^\circ$

- (b) low $\Delta_{\text{bond}}H^\circ$ and high $\Delta_{\text{hyd}}H^\circ$
 (c) high $\Delta_{\text{bond}}H^\circ$ and high $\Delta_{\text{eg}}H^\circ$
 (d) low $\Delta_{\text{hyd}}H^\circ$ and low $\Delta_{\text{eg}}H^\circ$

20. Which of the following sugar is known as dextrose?
 (a) Glucose (b) Fructose
 (c) Ribose (d) Sucrose
21. Cu reacts with dilute HNO_3 to evolve which gas?
 (a) N_2O (b) NO_2 (c) NO (d) N_2
22. Which of the following is a network solid?
 (a) SO_2 (b) SiO_2 (c) CO_2 (d) H_2O
23. Major product formed in the following reaction



24. Chlorine reacts with cold and dilute NaOH to give
 (a) NaCl and NaClO_3 (b) NaCl and NaClO
 (c) NaCl and NaClO_4 (d) NaClO and NaClO_3
25. Elevation of boiling point is inversely proportional to
 (a) molal elevation constant (K_b)
 (b) molality (m)
 (c) molar mass of solute (M)
 (d) weight of solute (W).

SECTION-B

This section of 24 multiple choice questions with overall choice to attempt any 20 questions. In case more than desirable number of questions are attempted, ONLY first 20 will be considered for evaluation.

26. An unknown gas 'X' is dissolved in water at 2.5 bar pressure and has mole fraction 0.04 in solution. The mole fraction of 'X' gas when the pressure of gas is doubled at the same temperature is
 (a) 0.08 (b) 0.04 (c) 0.02 (d) 0.92

27. The base which is present in DNA but not in RNA, is
 (a) cytosine (b) guanine
 (c) adenine (d) thymine.

28. In the following reaction
 $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_2 - \text{OH} \xrightarrow{\text{PCC}}$
 the product formed is
 (a) $\text{CH}_3 - \text{CHO}$ and $\text{CH}_3\text{CH}_2\text{OH}$
 (b) $\text{CH}_3 - \text{CH} = \text{CH} - \text{COOH}$
 (c) $\text{CH}_3 - \text{CH} = \text{CH} - \text{CHO}$
 (d) $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CHO}$

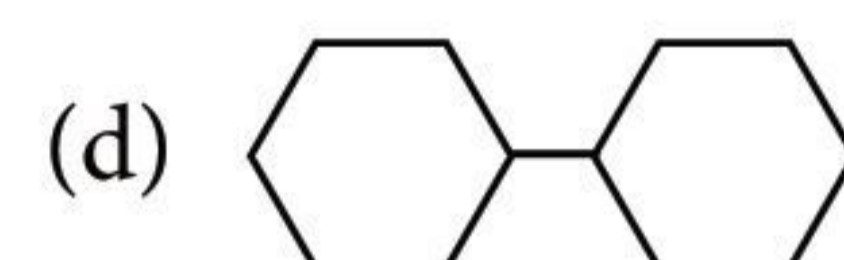
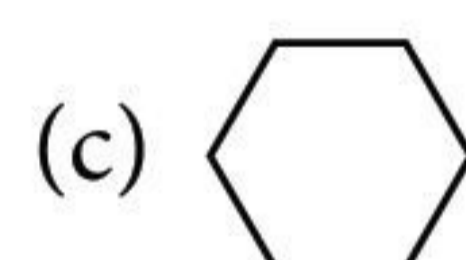
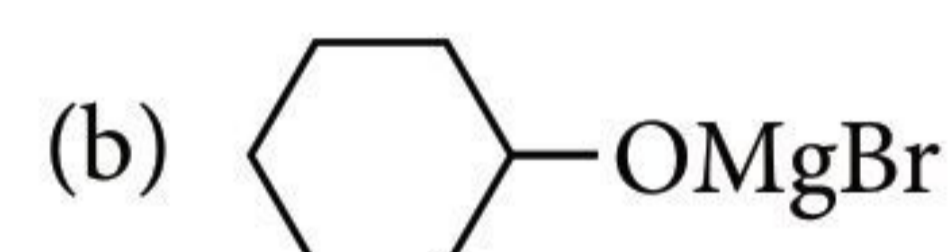
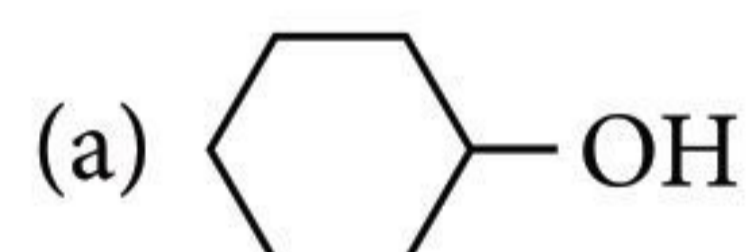
29. Enantiomers differ only in
 (a) boiling point
 (b) rotation of polarised light
 (c) melting point (d) solubility.

30. The number of lone pairs of electrons in XeF_4 is
 (a) zero (b) one
 (c) two (d) three.

31. Sulphuric acid is used to prepare more volatile acids from their corresponding salts due to its
 (a) strong acidic nature
 (b) low volatility
 (c) strong affinity for water
 (d) ability to acts as a dehydrating agent.

32. An element with density 6 g cm^{-3} forms a *fcc* lattice with edge length of $4 \times 10^{-8} \text{ cm}$. The molar mass of the element is ($N_A = 6 \times 10^{23} \text{ mol}^{-1}$)
 (a) 57.6 g mol^{-1} (b) 28.8 g mol^{-1}
 (c) 82.6 g mol^{-1} (d) 62 g mol^{-1}

33. In the reaction $\text{Cyclohexyl-Br} \xrightarrow[\text{dry ether}]{\text{Mg}} \text{'X'} \xrightarrow{\text{H}_2\text{O}} \text{'Y'}$
 compound 'Y' is



34. Which of the following is the weakest reducing agent in group 15?
 (a) NH_3 (b) PH_3 (c) AsH_3 (d) BiH_3

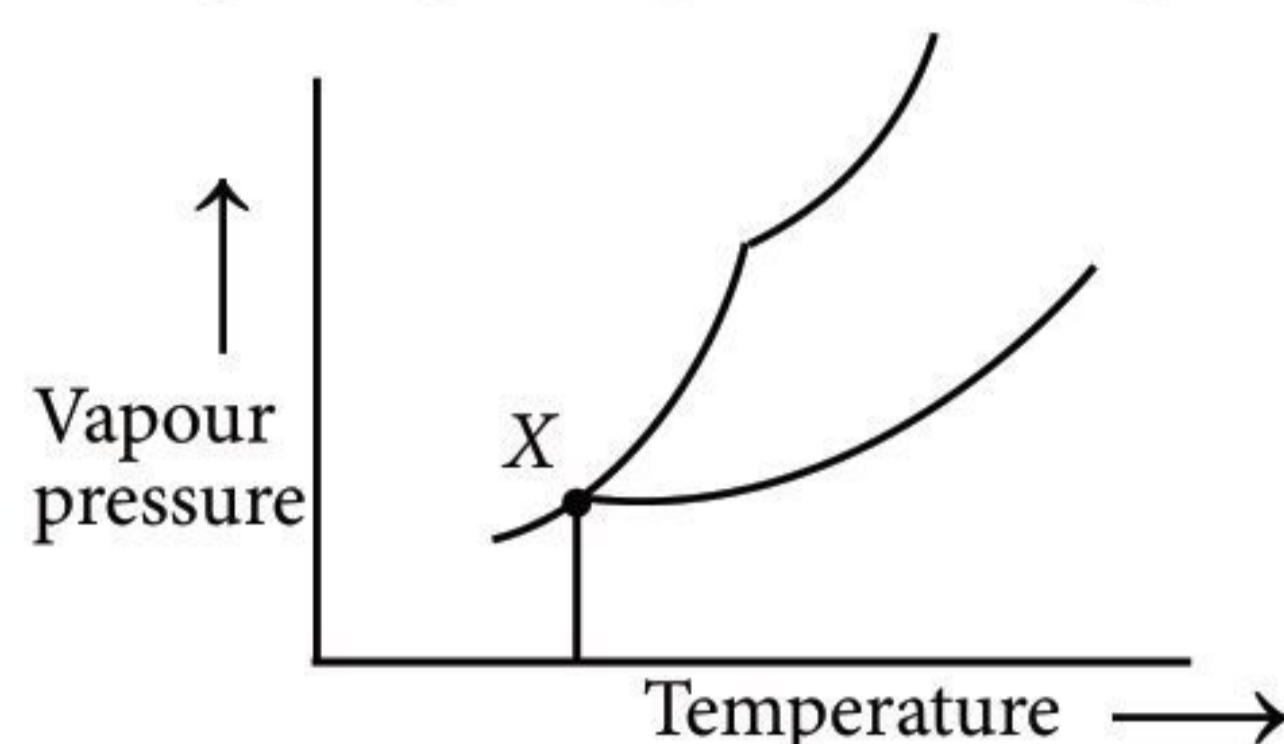
35. The boiling point of a 0.2 m solution of a non-electrolyte in water is (K_b for water = $0.52 \text{ K kg mol}^{-1}$)
 (a) 100°C (b) 100.52°C
 (c) 100.104°C (d) 100.26°C

36. Nucleic acids are polymer of
 (a) amino acids (b) nucleosides
 (c) nucleotides (d) glucose.

37. Which of the following gas dimerises to become stable?

- (a) $\text{CO}_{2(g)}$ (b) $\text{NO}_{2(g)}$ (c) $\text{SO}_{2(g)}$ (d) $\text{N}_2\text{O}_{(g)}$

38. In the following diagram point 'X' represents



- (a) boiling point of solution
(b) freezing point of solvent
(c) boiling point of solvent
(d) freezing point of solution.

39. XeF_6 on reaction with NaF gives

- (a) $\text{Na}^+[\text{XeF}_7]^-$ (b) $[\text{NaF}_2]^-[\text{XeF}_5]^+$
(c) $\text{Na}^+[\text{XeF}_6]^-$ (d) $[\text{NaF}_2]^+[\text{XeF}_5]^-$

40. Glucose on reaction with Br_2 water gives

- (a) saccharic acid (b) hexanoic acid
(c) gluconic acid (d) salicylic acid.

41. Which of the following is optically inactive?

- (a) (+) -Butan-2-ol (b) (-) -Butan-2-ol
(c) (\pm) -Butan-2-ol (d) (+) -2-Bromobutane

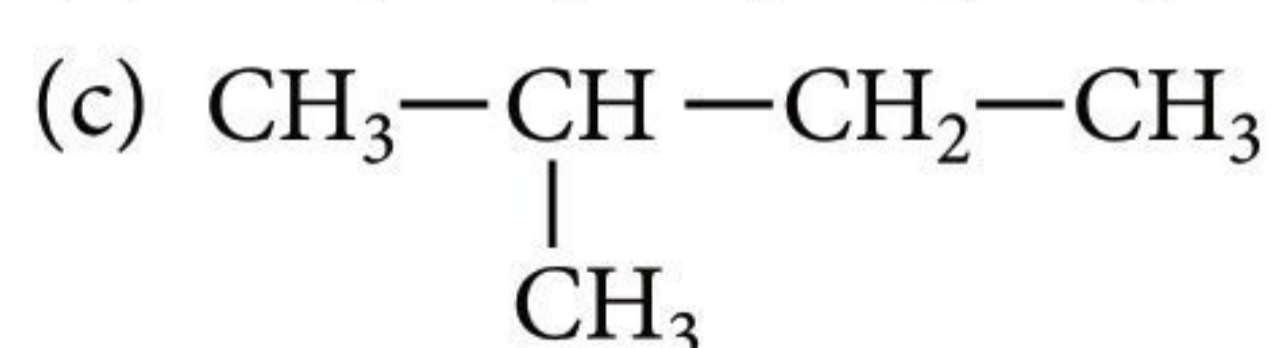
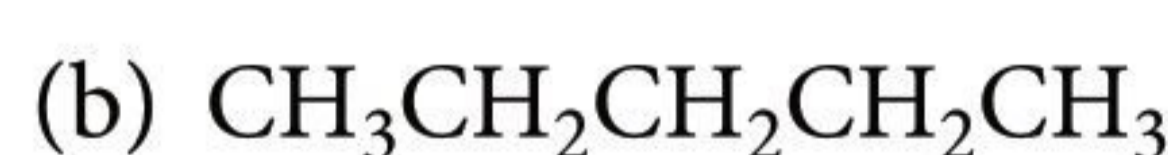
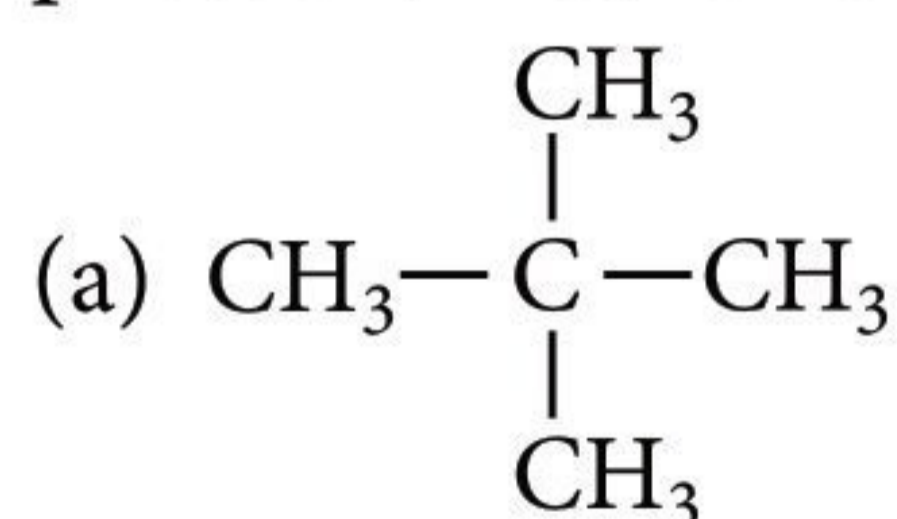
42. Which of the following is not a correct statement?

- (a) Halogens are strong oxidising agents.
(b) Halogens are more reactive than interhalogens.
(c) All halogens are coloured.
(d) Halogens have maximum negative electron gain enthalpy.

43. Which of the following has highest boiling point?

- (a) $\text{C}_2\text{H}_5 - \text{F}$ (b) $\text{C}_2\text{H}_5 - \text{Cl}$
(c) $\text{C}_2\text{H}_5 - \text{Br}$ (d) $\text{C}_2\text{H}_5 - \text{I}$

44. Which of the following isomer of pentane (C_5H_{12}) will give three isomeric monochlorides on photochemical chlorination?



- (d) All of the above.

Directions : Given below are the questions (45-49) labelled as Assertion (A) and Reason (R).

Select the most appropriate answer from the options given below.

45. **Assertion(A) :** A raw mango placed saline solution loses water and shrivel into pickle.

Reason (R) : Through the process of reverse osmosis raw mango shrivel into pickle.

- (a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true and R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

46. **Assertion (A) :** H_2S is less acidic than H_2Te .

Reason (R) : $\text{H} - \text{S}$ bond has more $\Delta_{\text{bond}}H^\circ$ than $\text{H} - \text{Te}$ bond

- (a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true and R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

47. **Assertion (A) :** Chlorobenzene is less reactive towards nucleophilic substitution reaction

Reason (R) : Nitro group in chlorobenzene increases its reactivity towards nucleophilic substitution reaction

- (a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true and R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

48. **Assertion (A) :** Due to Schottky defect, there is no effect on the density of a solid.

Reason (R) : Equal number of cations and anions are missing from their normal sites in Schottky defect.

- (a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true and R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

49. Assertion (A) : Fluorine forms only one oxoacid HOF.

Reason (R) : Fluorine atom is highly electronegative.

- (a) Both A and R are true and R is the correct explanation of A
 (b) Both A and R are true and R is not the correct explanation of A
 (c) A is true but R is false
 (d) A is false but R is true

SECTION-C

This section consists of 6 multiple choice questions with an overall choice to attempt an 5. In case more than desirable number of questions are attempted, ONLY first 5 will be considered for evaluation.

50. Match the following

I		II	
(i)	Stoichiometric defects	(A)	Crystalline solids
(ii)	Long range order	(B)	F-centres
(iii)ABC ABC ABC	(C)	Schottky and Frenkel defects
(iv)	Number of atoms per unit cell = 2	(D)	fcc structure
(v)	Metal excess defect due to anionic vacancies		

Which of the following is the best matched options?

- (a) (i) – (A), (ii) – (A), (iii) – (B), (iv) – (C)
 (b) (i) – (C), (ii) – (A), (iii) – (D), (v) – (B)
 (c) (i) – (C), (ii) – (A), (iii) – (D), (iv) – (B)
 (d) (i) – (A), (ii) – (B), (v) – (C), (iv) – (D)

51. Which of the following analogies is correct?

- (a) XeF_2 : linear :: XeF_6 : square planar
 (b) Moist SO_2 : Reducing agent :: Cl_2 : bleaching agent
 (c) N_2 : Highly reactive gas :: F_2 : inert at room temperature
 (d) NH_3 : strong base :: HI : weak acid

52. Complete the following analogy :

Curdling of milk : A :: α -helix : B

- (a) A : Primary structure , B : Secondary structure
 (b) A : Denatured protein, B : Primary structure
 (c) A : Secondary structure, B : Denatured protein
 (d) A : Denatured protein, B : Secondary structure

Case : Read the passage given below and answer the following question (53–55).

Alcohols and phenols are acidic in nature. Electron withdrawing groups in phenol increase its acidic strength and electron donating groups decrease it. Alcohols undergo nucleophilic substitution with hydrogen halides to give alkyl halides. On oxidation primary alcohols yield aldehydes with mild oxidising agents and carboxylic acids with strong oxidising agents while secondary alcohols yield ketones. The presence of —OH groups in phenols activates the ring towards electrophilic substitution. Various important products are obtained from phenol like salicylaldehyde, salicylic acid, picric acid etc.

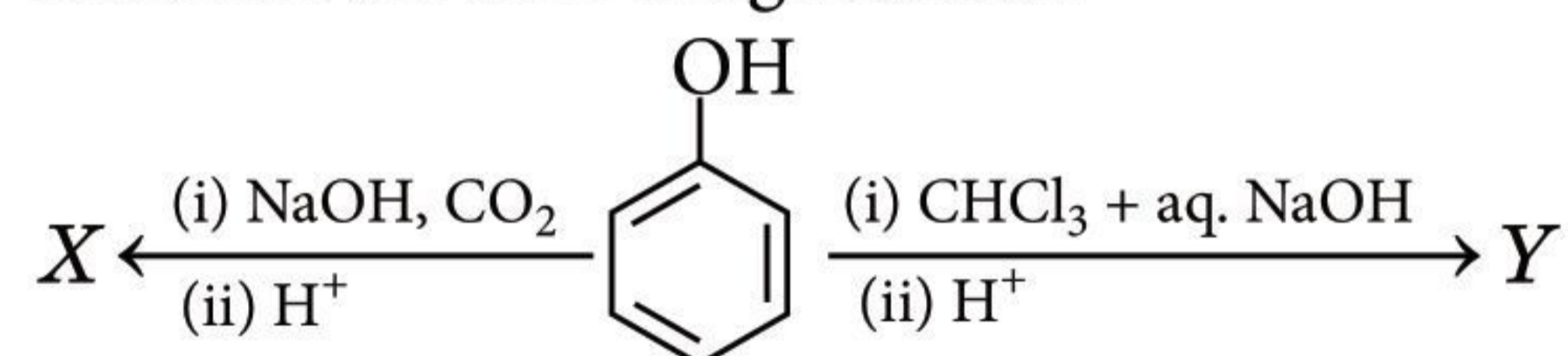
53. Which of the following alcohols is resistant to oxidation?

- (a) $\text{CH}_3 - \overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{C}}} - \text{OH}$ (b) $\text{CH}_3 - \underset{\text{CH}_3}{\text{CH}} - \text{OH}$
 (c) $\text{CH}_3 - \text{CH}_2 - \text{OH}$ (d) $\text{CH}_3 - \text{OH}$

54. Which of the following group increases the acidic character of phenol?

- (a) $\text{CH}_3\text{O} -$ (b) $\text{CH}_3 -$
 (c) $\text{NO}_2 -$ (d) All of these

55. Consider the following reaction



the products X and Y are

- (a) $\text{X} = \text{C}_6\text{H}_4(\text{OH})(\text{COOH})$ $\text{Y} = \text{C}_6\text{H}_4(\text{OH})(\text{CHO})$
 (b) $\text{X} = \text{C}_6\text{H}_4(\text{OH})(\text{CHO})$ $\text{Y} = \text{C}_6\text{H}_4(\text{OH})(\text{COOH})$
 (c) $\text{X} = \text{C}_6\text{H}_4(\text{COOH})(\text{OH})$ $\text{Y} = \text{C}_6\text{H}_4(\text{OH})(\text{CHO})$
 (d) $\text{X} = \text{C}_6\text{H}_4(\text{OH})(\text{COOH})$ $\text{Y} = \text{C}_6\text{H}_4(\text{OH})(\text{CHO})$

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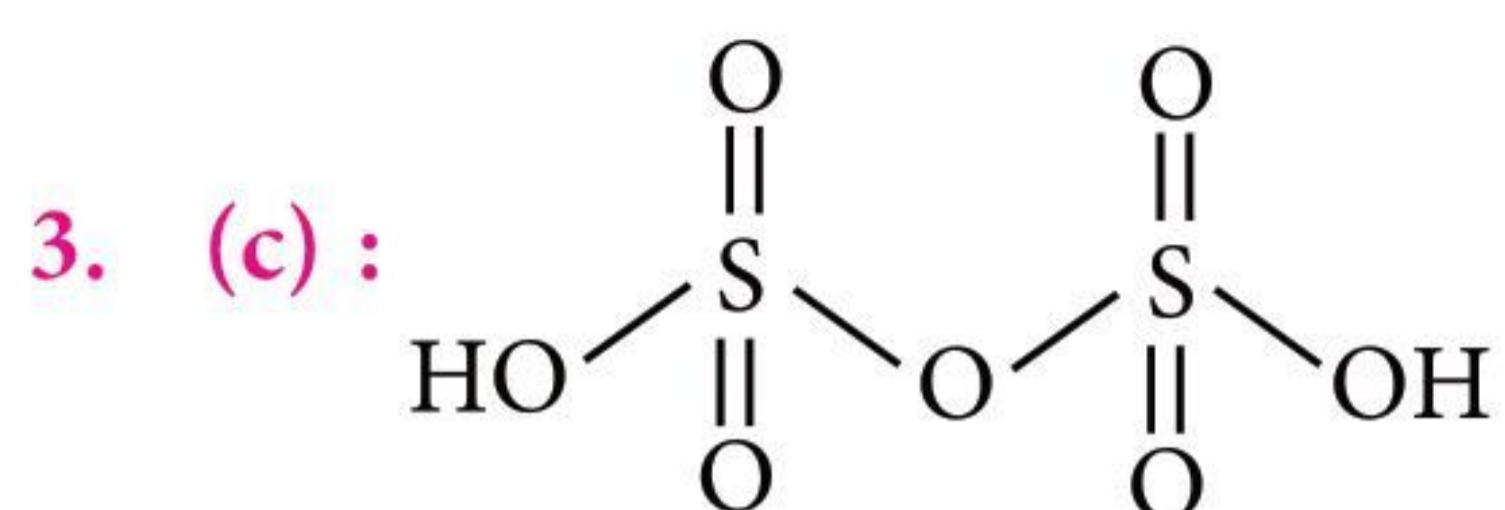
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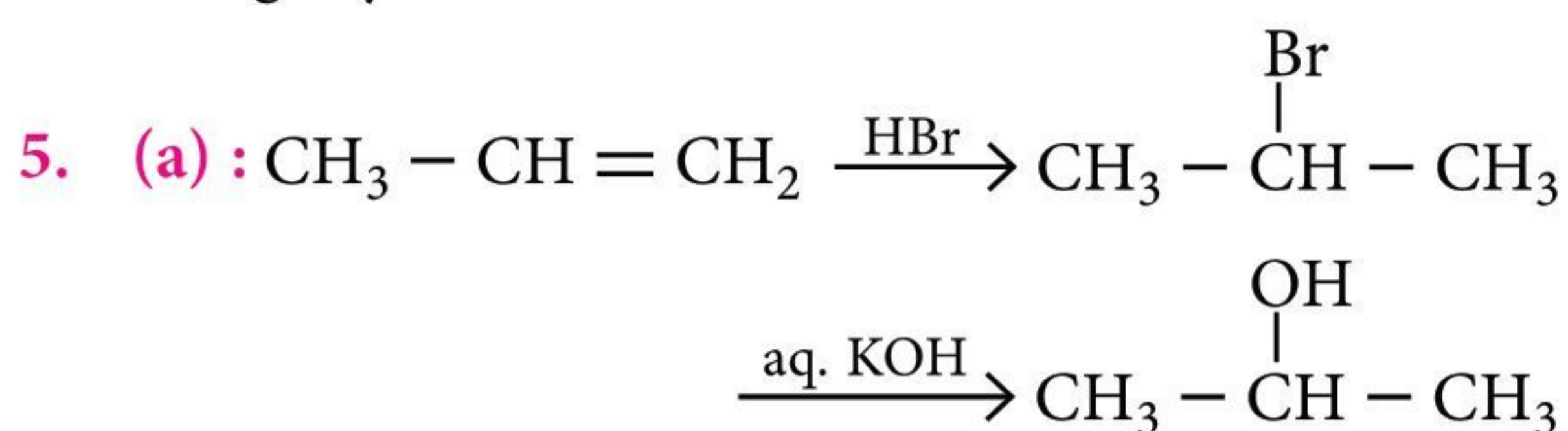
SOLUTIONS

1. (c) : *n*-Hexane and *n*-heptane form an ideal solution.

2. (d) : Glass, plastic and rubber all are amorphous solids.



4. (b) : C—O—H bond angle in alcohol is 108.9° that is slightly less than 109.28° .



6. (c) : Nucleosides are composed of a pentose sugar and a nitrogenous base.

7. (a) : Oxygen will show -2 oxidation state more strongly.

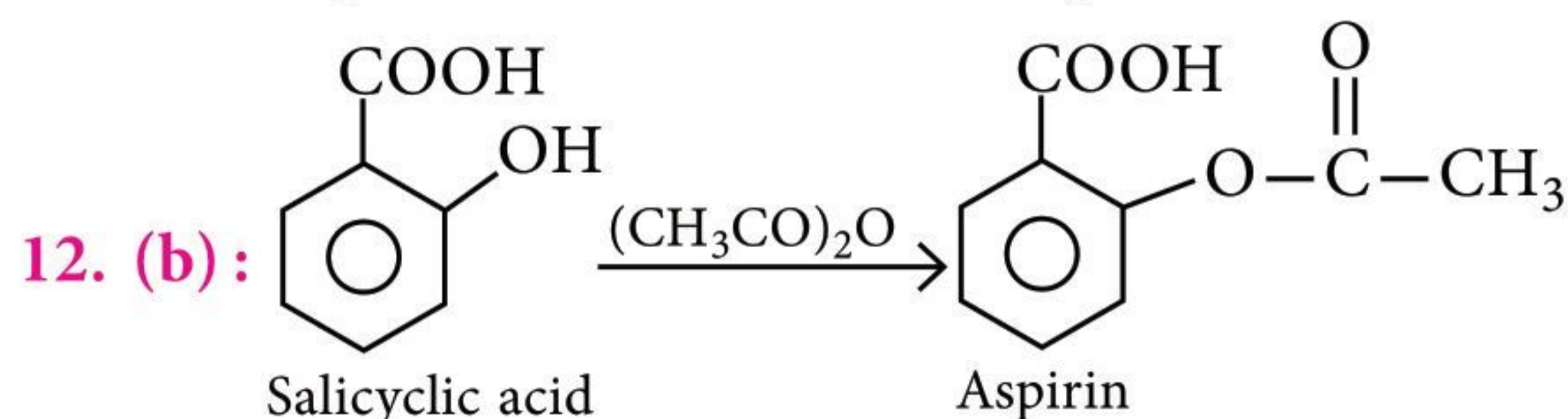
8. (d) : Crystalline solids are anisotropic in nature.

9. (c) : When a non-volatile solute added to the volatile liquid, then partial pressure is only due to volatile component.

$$\text{So, } p_{\text{total}} = P_{\text{solvent}}$$

10. (a) : Solutions which show positive deviation from Raoult's law are minimum boiling azeotropes or have a lower boiling point than either of the two components.

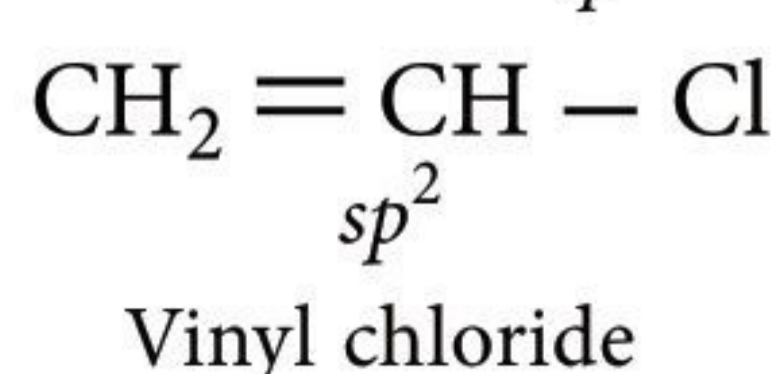
11. (d) : ZnO will show metal excess defect due to extra cation present in the interstitial position.



13. (d) : O—O bond is weaker than S—S due to interelectronic repulsion.

14. (b) : Essential amino acids must be taken through diet as these cannot be synthesised in the body.

15. (d) : Vinyl halide contain $\text{C}_{sp^2} - \text{X}$ bond.



16. (a) : Acetone and chloroform form H-bonding due to which molecules come closer to each other and the volume of solution decreases.

17. (c) : The correct order of $\text{S}_{\text{N}}2$ reaction is $\text{II} > \text{I} > \text{III}$.

18. (d) : Oxygen will form strong $p\pi-p\pi$ bond due to smaller size and high electronegativity.

19. (b) : Due to low bond dissociation enthalpy and high hydration enthalpy, F_2 act as strong oxidising agent.

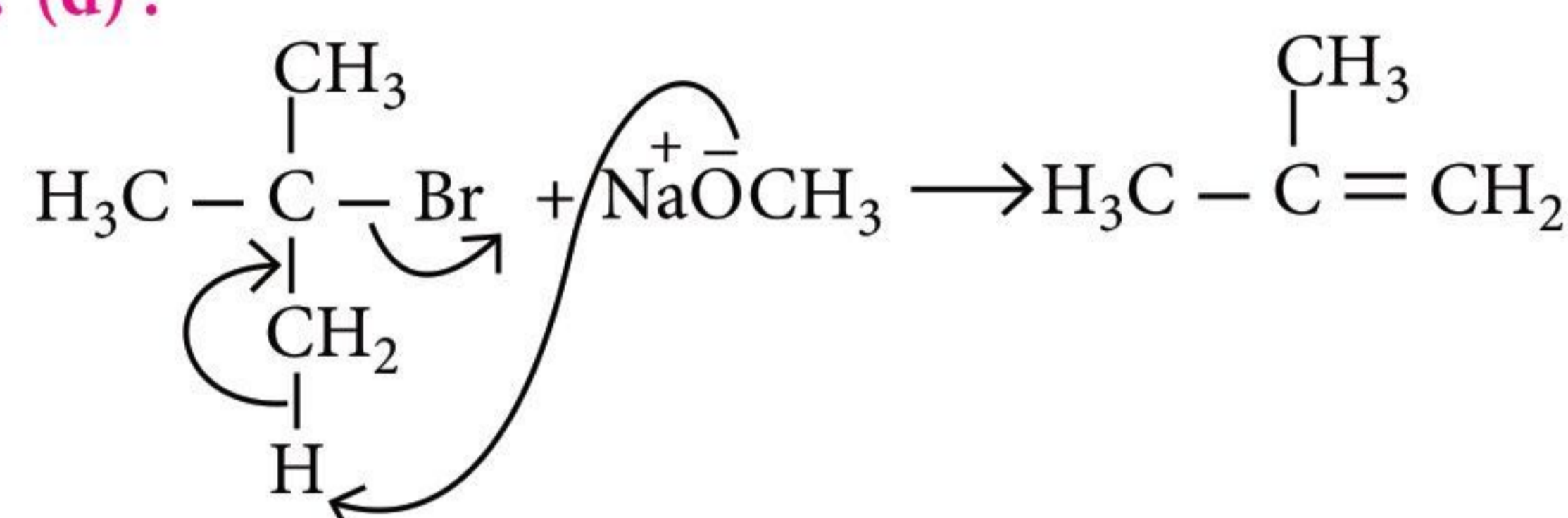
20. (a) : Glucose is known as dextrose.

21. (c) : $\text{NO}_{(\text{g})}$ is released when Cu react with dil. HNO_3 .



22. (b) : SiO_2 is a network solid or covalent solid.

23. (d) :



24. (b) : $\text{Cl}_2 + 2\text{NaOH} \longrightarrow \text{NaCl} + \text{NaOCl} + \text{H}_2\text{O}$
 (dil. and cold)

25. (c) : $\Delta T_f = K_f \times \frac{W}{\text{molar mass}} \times \frac{1}{w_{\text{solvent}}} \times 1000$

According to the formula,

$$\Delta T_f \propto \frac{1}{\text{molar mass of solute}}$$

26. (a) : According to Henry's law, $p = k_H x$

$$2.5 \text{ bar} = k_H \times 0.04$$

$$k_H = \frac{2.5}{0.04} = 62.5 \text{ bar}$$

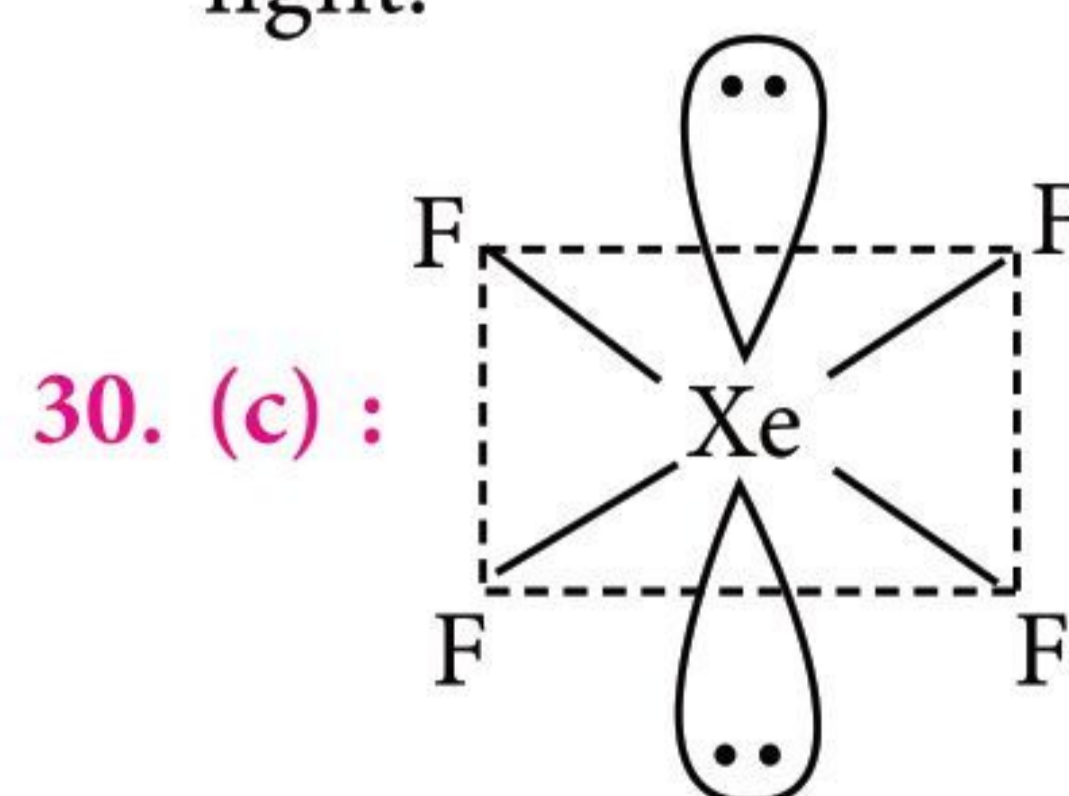
When pressure is doubled, then x is

$$5 \text{ bar} = 62.5 \times x \Rightarrow x = 0.08$$

27. (d) : Thymine is present in DNA but not in RNA.

28. (c) : $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_2\text{OH} \xrightarrow{\text{PCC}} \text{CH}_3 - \text{CH} = \text{CH} - \text{CHO}$

29. (b) : Enantiomers differ only in rotation of polarised light.



It has two lone pairs of electrons on Xe.

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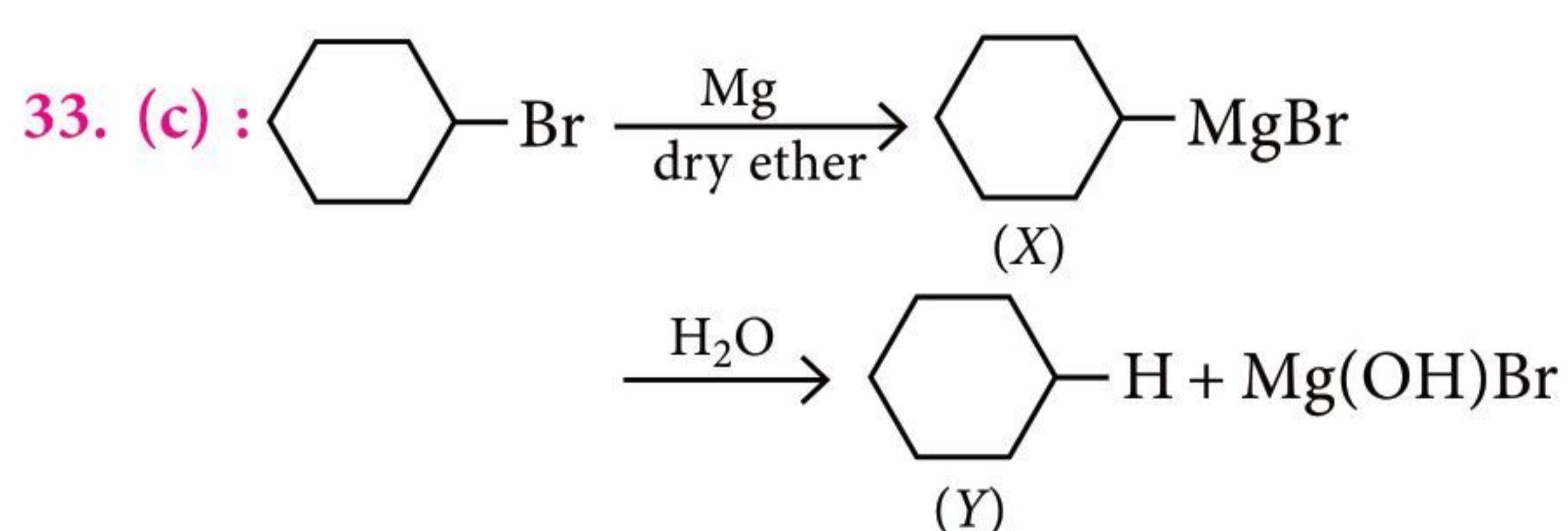
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31. (b) : Due to its low volatility, it can be used to manufacture more volatile acids from their corresponding salt.

32. (a) : $\rho = 6 \text{ g cm}^{-3}$, $a = 4 \times 10^{-8} \text{ cm}$
 $Z = 4$, $N_A = 6.022 \times 10^{23}$

$$\rho = \frac{Z \times M}{a^3 \times N_A}; M = \frac{\rho \times a^3 \times N_A}{Z}$$

$$M = \frac{6 \times 64 \times 10^{-24} \times 6.022 \times 10^{23}}{4} = 57.8 \text{ g mol}^{-1}$$



34. (a) : NH_3 is the weakest reducing agent due to high (N — H) bond dissociation enthalpy.

35. (c) : $\Delta T_b = K_b \times m$

$$T_b - T_b^\circ = 0.52 \times 0.2$$

$$T_b = 0.104 + T_b^\circ$$

$$T_b = (0.104 + 100)^\circ\text{C} = 100.104^\circ\text{C}$$

36. (c) : Nucleic acids are polymer of nucleotides.

37. (b) : NO_2 contain odd number of electrons. So it dimerises to become stable N_2O_4 molecule.

38. (d) : X represents freezing point of solution.

39. (a) : $\text{XeF}_6 + \text{NaF} \longrightarrow \text{Na}^+[\text{XeF}_7]^-$

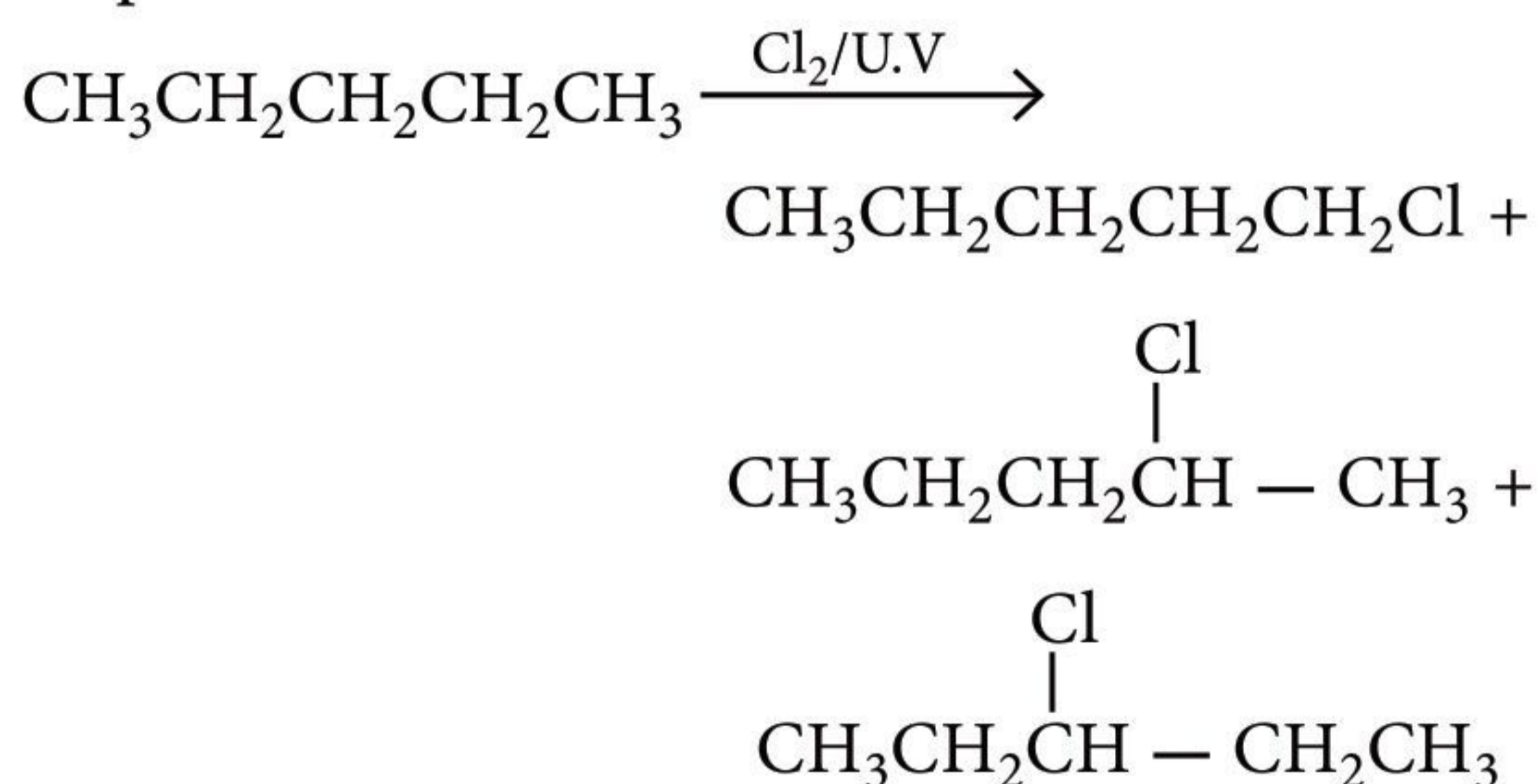
40. (c) : Glucose on reaction with Br_2 water gives gluconic acid.

41. (c) : (\pm)-Butan-2-ol is optically inactive

42. (b) : Halogens are less reactive than interhalogen compounds due to polarity.

43. (d) : $\text{C}_2\text{H}_5 - \text{I}$ has highest boiling point due to higher molecular mass.

44. (b) : *n*-Pentane will give three isomeric monochlorides on photochemical chlorination.



45. (c) : A raw mango shriveled into pickle due to osmosis.

46. (a) : Due to high bond dissociation enthalpy of H — S bond, it is less acidic than H_2Te .

47. (b) : Chlorobenzene is less reactive towards nucleophilic substitution reaction due to partial double bond character of C — X bond that is very difficult to break.

48. (d) : Due to Schottky defect, density of unit cell decreases.

49. (a) : Fluorine forms only one oxoacid due to high electronegativity and small size.

50. (b) : The correct matching is
 (i) - C, (ii) - A, (iii) - D, (v) - B

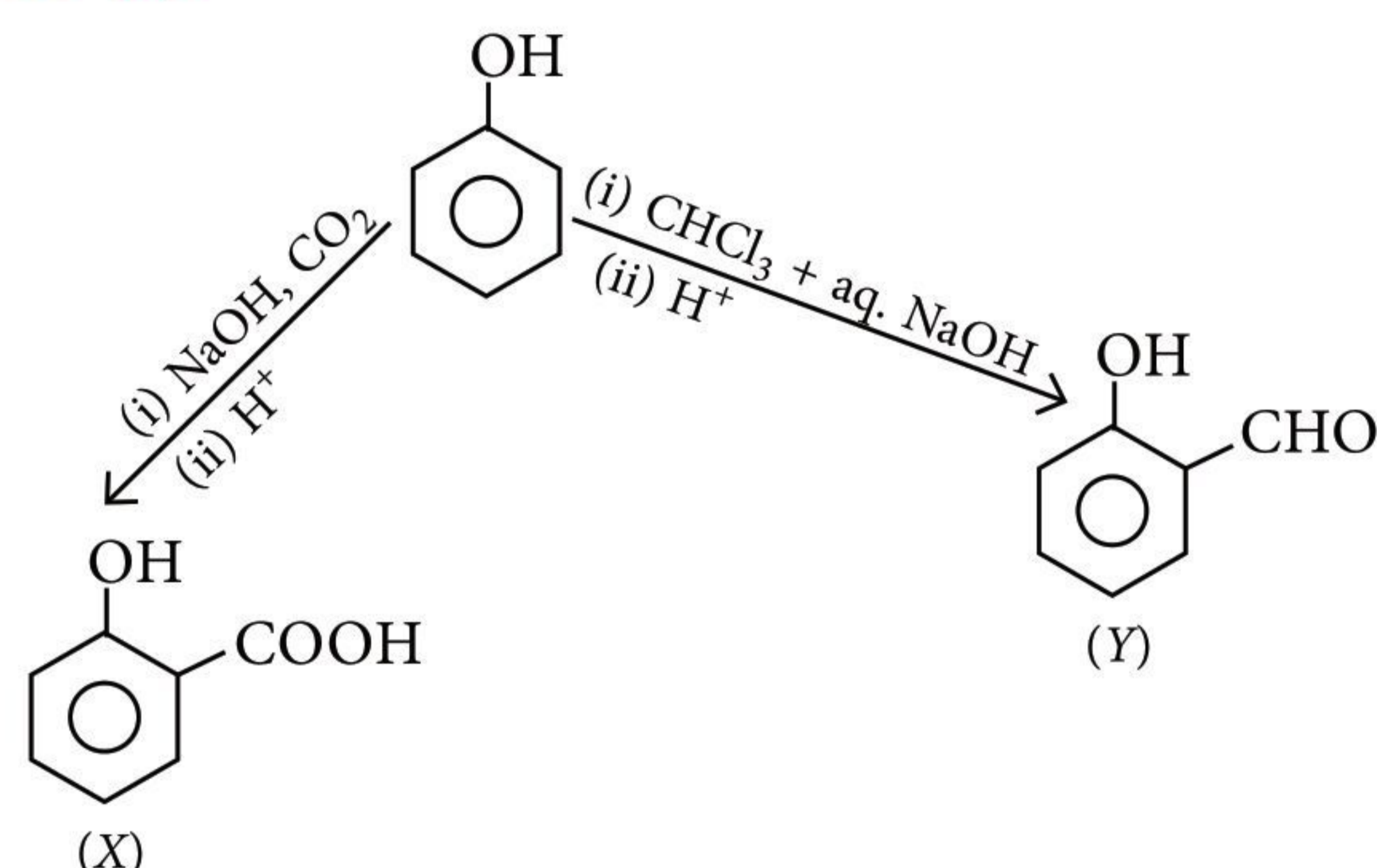
51. (b) : Moist SO_2 act as strong reducing agent and Cl_2 act as bleaching agent.

52. (d) : Curdling of milk – denatured protein
 α -helix – secondary structure

53. (a) : Tertiary alcohols do not undergo oxidation.

54. (c) : $-\text{NO}_2$ acts as EWG and increases the polarity of O—H bond resulting in increased acidic character of phenol.

55. (d) :



MONTHLY TEST DRIVE CLASS XI ANSWER KEY

1. (b)	2. (b)	3. (b)	4. (c)	5. (c)
6. (d)	7. (b)	8. (c)	9. (c)	10. (a)
11. (b)	12. (c)	13. (a)	14. (d)	15. (c)
16. (a)	17. (c)	18. (c)	19. (b)	20. (c,d)
21. (a,b,d)	22. (a,b,c)	23. (a,c)	24. (0)	25. (4)
26. (2)	27. (a)	28. (d)	29. (d)	30. (d)



CBSE warm-up!

Term-II

CLASS-XII

Series-1

Electrochemistry | The *d*- and *f*-Block Elements | Aldehydes, Ketones and Carboxylic Acids

Time Allowed : 2 hours
Maximum Marks : 35

General Instructions : Read the following instructions carefully.

- There are 16 questions in this question paper. All questions are compulsory.
- Section A : Q. No. 1 to 8 are objective type questions. Q. No. 1 is passage based question carrying 4 marks while Q. No. 2 to 8 carry 1 mark each.
- Section B : Q. No. 9 to 12 are short answer questions and carry 2 marks each.
- Section C : Q. No. 13 and 14 are short answer questions and carry 3 marks each.
- Section D : Q. No. 15 and 16 are long answer questions carrying 5 marks each.
- There is no overall choice. However, internal choices have been provided.
- Use of calculators and log tables is not permitted.

SECTION - A (OBJECTIVE TYPE)

1. Read the passage given below and answer the following questions :

Specific Conductance or Conductivity (κ)

$$\kappa = G \times \frac{l}{a} = \frac{1}{R} \times \frac{l}{a}$$

$\frac{l}{a}$ = cell constant
Unit = $\text{S m}^{-1} = \Omega^{-1} \text{m}^{-1}$

Equivalent Conductivity (Λ_{eq})

$$\Lambda_{eq} = \kappa \times V (\text{in mL}) = \kappa \times \frac{1000}{C} = \kappa \times \frac{1000}{N}$$

Unit = $\text{S cm}^2 \text{eq}^{-1}$ or $\Omega^{-1} \text{cm}^2 \text{eq}^{-1}$

Conductance / Conductivity

Conductance (G) : $G = \frac{1}{R}$
Unit = Ω^{-1} or mho

Molar Conductivity (Λ_m)

$$\Lambda_m = \kappa \times V (\text{in mL}) = \kappa \times \frac{1000}{M}$$

Unit = $\text{S cm}^2 \text{mol}^{-1}$ or $\Omega^{-1} \text{cm}^2 \text{mol}^{-1}$

The following questions are multiple choice questions. Choose the most appropriate answer :

- The molar conductivity of 0.025 mol L^{-1} methanoic acid is $46.1 \text{ S cm}^2 \text{mol}^{-1}$, its dissociation constant is (Given : $\lambda_{\text{H}^+}^\circ = 349.6 \text{ S cm}^2 \text{mol}^{-1}$ and $\lambda_{\text{HCOO}^-}^\circ = 54.6 \text{ S cm}^2 \text{mol}^{-1}$.)
- Given that Λ_m° values of BaCl_2 , Ba(OH)_2 and NH_4Cl in $\Omega^{-1} \text{cm}^2 \text{mol}^{-1}$ are 240.6, 461 and 129.8 respectively. The Λ_m° for NH_4OH in $\Omega^{-1} \text{cm}^2 \text{mol}^{-1}$ will be

- 3.14×10^{-3}
- 3.67×10^{-4}
- 4.15×10^{-4}
- 5.21×10^{-3}

**This is for practice purpose. CBSE has yet not released the official sample paper. So, the pattern is suggestive only. For latest information visit www.cbse.gov.in.*

- (a) 350.2 (b) 240.0
(c) 175.1 (d) 119.7

(iii) If a centinormal solution of NH_4OH has molar conductivity equal to $9.6 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$, the percentage dissociation of NH_4OH at this dilution will be

- (a) 8% (b) 12% (c) 6% (d) 4%

(iv) The equivalent conductances of two strong electrolytes at infinite dilution are

$$\Lambda_{\text{CH}_3\text{COONa}}^\circ = 91.0 \text{ S cm}^2/\text{eq}, \Lambda_{\text{HCl}}^\circ = 426.2 \text{ S cm}^2/\text{eq}.$$

What additional information/quantity does one need to calculate $\Lambda_{\text{CH}_3\text{COOH}}^\circ$?

- (a) $\Lambda_{\text{NaCl}}^\circ$ (b) $\Lambda_{\text{CH}_3\text{COOK}}^\circ$
(c) $\Lambda_{\text{ClCH}_2\text{COOH}}^\circ$
(d) $\lambda_{\text{H}^+}^\circ$ (the limiting equivalent conductance of H^+)

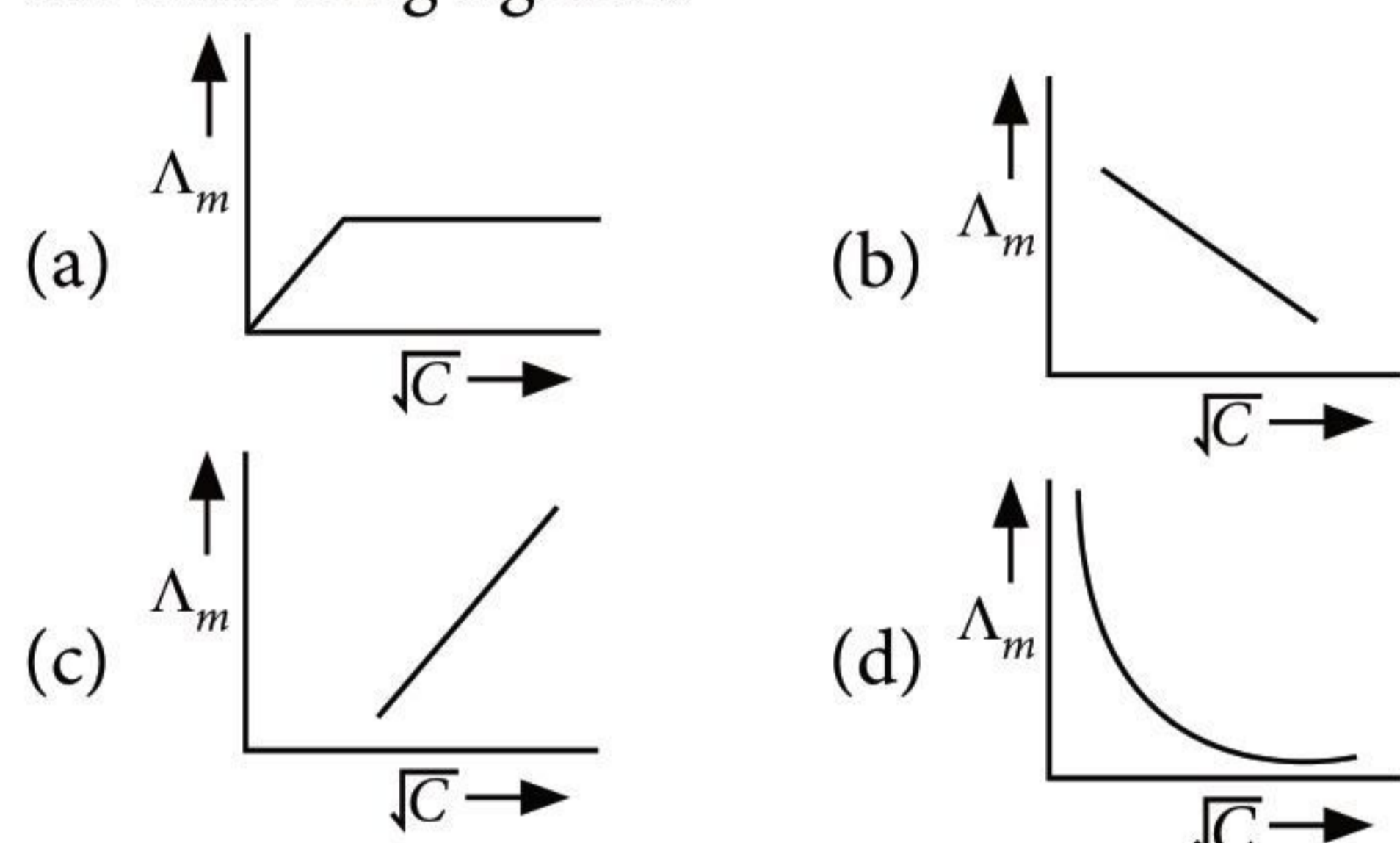
OR

Calculate the molar conductivity of a 0.0005 M BaCl_2 solution. (Given : specific conductance, $\kappa = 134.3 \times 10^{-6} \text{ S cm}^{-1}$)

- (a) $1343 \text{ S cm}^2 \text{ mol}^{-1}$ (b) $268.6 \text{ S cm}^2 \text{ mol}^{-1}$
(c) $26.86 \text{ S cm}^2 \text{ mol}^{-1}$ (d) $13.43 \text{ S cm}^2 \text{ mol}^{-1}$

Following questions (Q. No. 2-6) are multiple choice questions carrying 1 mark each :

2. The variation of equivalent conductance of weak electrolyte with \sqrt{C} is correctly shown in which of the following figures?



3. The correct order of ionic radii of Ce, La, Pm and Yb in +3 oxidation state is

- (a) $\text{La}^{3+} < \text{Pm}^{3+} < \text{Ce}^{3+} < \text{Yb}^{3+}$
(b) $\text{La}^{3+} < \text{Ce}^{3+} < \text{Pm}^{3+} < \text{Yb}^{3+}$
(c) $\text{Yb}^{3+} < \text{Ce}^{3+} < \text{Pm}^{3+} < \text{La}^{3+}$
(d) $\text{Yb}^{3+} < \text{Pm}^{3+} < \text{Ce}^{3+} < \text{La}^{3+}$

OR

Which of the following statements about the transition elements is not true?

- (a) All the transition elements are predominantly metallic.
(b) In aqueous solution, many of their simple ions are coloured.

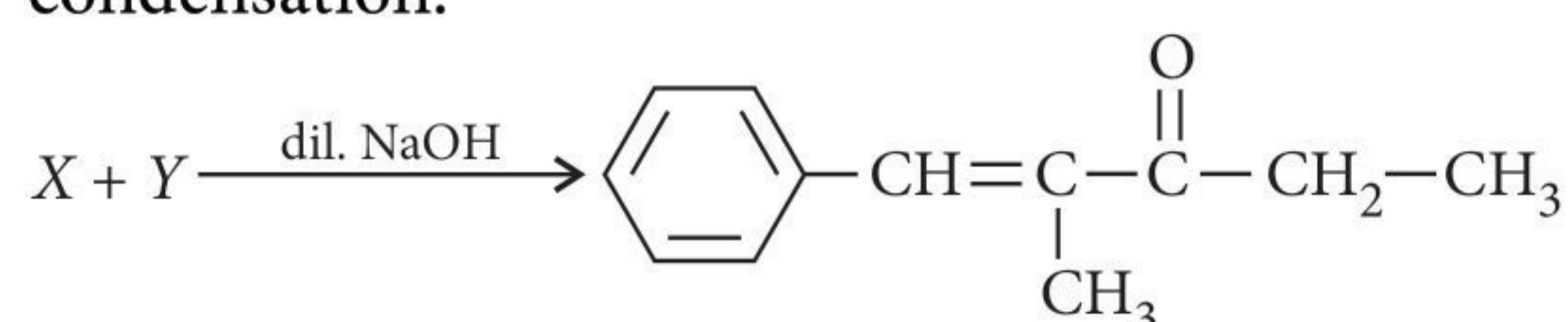
(c) Most of the transition elements show pronounced catalytic activity.

(d) Most of the transition elements show only one valency.

4. Standard electrode potential for $\text{Sn}^{4+}/\text{Sn}^{2+}$ couple is +0.15 V and that for the Cr^{3+}/Cr couple is -0.74 V. These two couples in their standard state are connected to make a cell. The cell potential will be

- (a) +1.83 V (b) +1.19 V
(c) +0.89 V (d) +0.18 V

5. Identify the starting reagents (X and Y) needed to make the following compound by crossed aldol condensation.

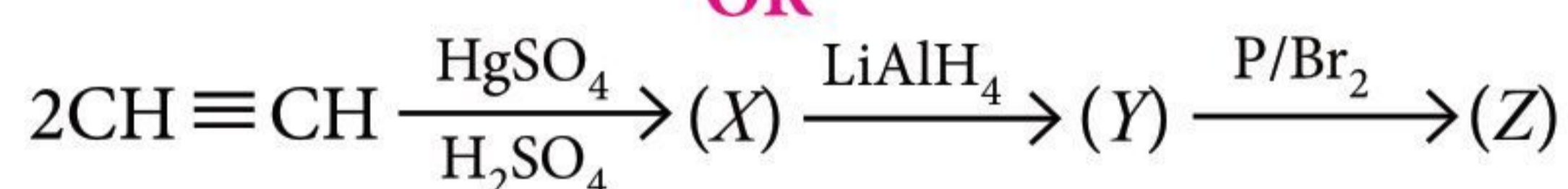


- (a) Acetophenone and butanal
(b) Benzaldehyde and 2-pentanone
(c) Acetophenone and 2-butanone
(d) Benzaldehyde and 3-pentanone

6. The correct sequence of steps involved in the mechanism of Cannizzaro reaction is

- (a) nucleophilic attack, transfer of H^- and transfer of H^+
(b) transfer of H^- , transfer of H^+ and nucleophilic attack
(c) transfer of H^+ , nucleophilic attack and transfer of H^-
(d) electrophilic attack by OH^- , transfer of H^+ and transfer of H^- .

OR



In the given sequence of reactions, (Z) is

- (a) ethylene bromide (b) ethanol
(c) ethyl bromide (d) ethylidene bromide.

In the following questions (Q. No. 7 and 8), a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

- (a) Assertion and reason both are correct statements and reason is correct explanation for assertion.
(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.
(c) Assertion is correct statement but reason is wrong statement.
(d) Assertion is wrong statement but reason is correct statement.

7. **Assertion :** Equivalent conductance increases with dilution for an electrolytic solution.

Reason : The molar conductivity versus \sqrt{C} for acetic acid in aqueous solution is a straight line graph.

OR

Assertion : Ce^{4+} is used as an oxidising agent in volumetric analysis.

Reason : Ce^{4+} has the tendency of attaining +3 oxidation state.

8. **Assertion :** Lanthanoids show a limited number of oxidation state whereas actinoids show a large number of oxidation states.

Reason : Energy gap between 4f, 5d and 6s subshells is small whereas that between 5f, 6d and 7s subshells is large.

SECTION - B

The following questions Q. No. 9-12 are short answer type and carry 2 marks each.

9. Calculate the EMF of the following cell when 99.99% of the Cu^{2+} ions has been consumed.
 $\text{Zn} \mid \text{Zn}^{2+} (1 \text{ M}) \parallel \text{Cu}^{2+} (1 \text{ M}) \mid \text{Cu}$, $E^\circ = 1.10 \text{ V}$

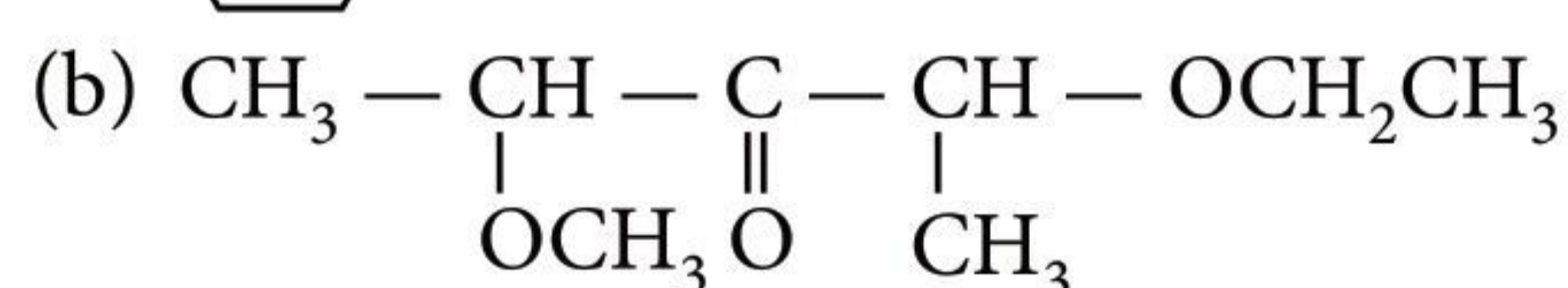
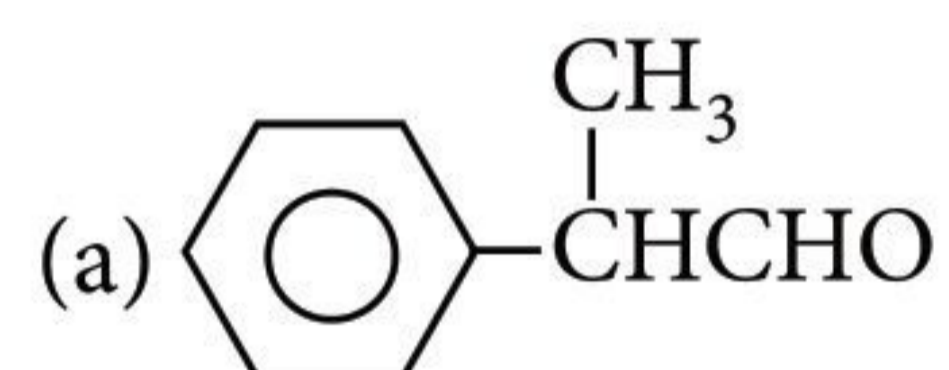
OR

Calculate the electrode potential of the zinc electrode at 25°C when $[\text{Zn}^{2+}] = 0.001 \text{ M}$. ($E^\circ_{\text{Zn}^{2+}|\text{Zn}} = -0.76 \text{ V}$)

10. Write the formula of the oxo-metal anions of the first series of the transition metals in which the metal exhibits the oxidation state equal to its group number.
11. Write the electronic configurations of the elements with the atomic numbers 61, 91, 101 and 109.
12. Arrange the following compounds in the increasing order of their boiling points:
 $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$,
 $\text{C}_2\text{H}_5\text{—O—C}_2\text{H}_5$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

OR

Write the IUPAC names of the following:

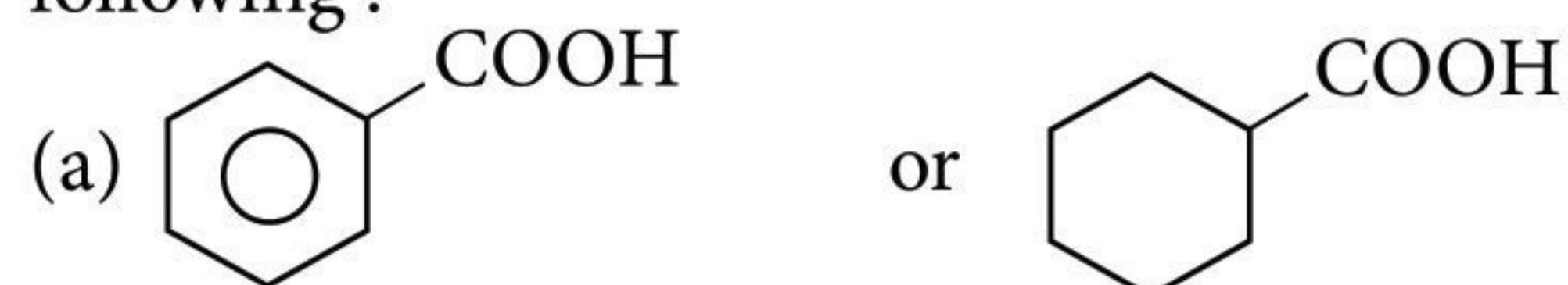


SECTION - C

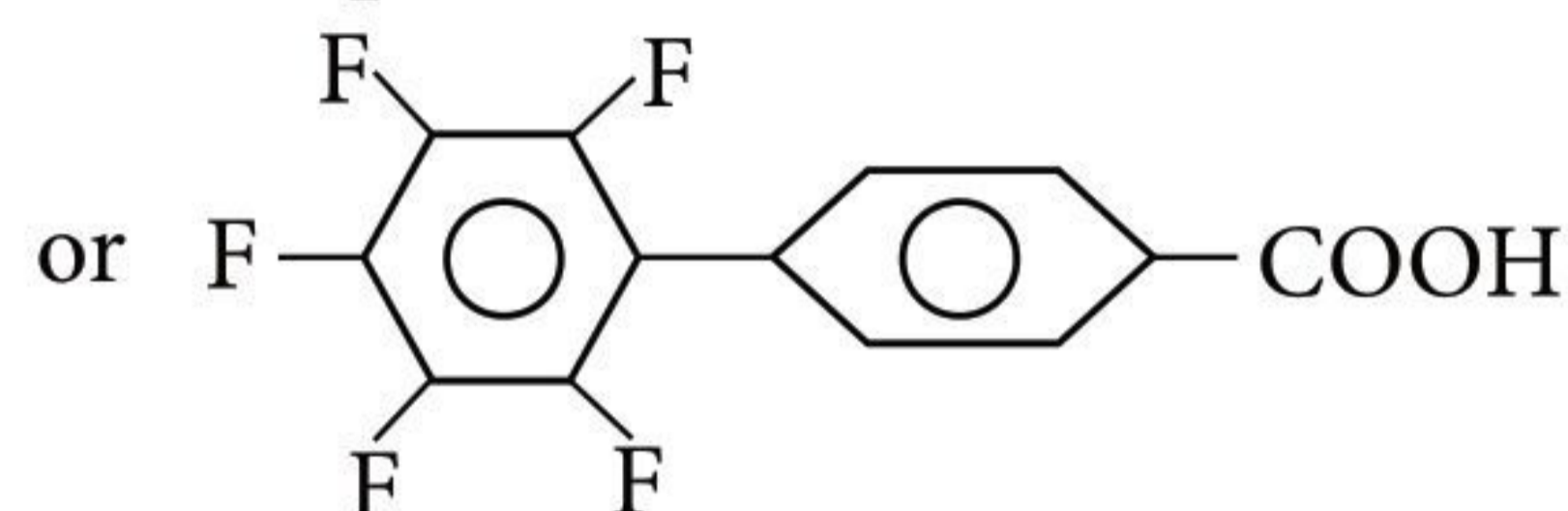
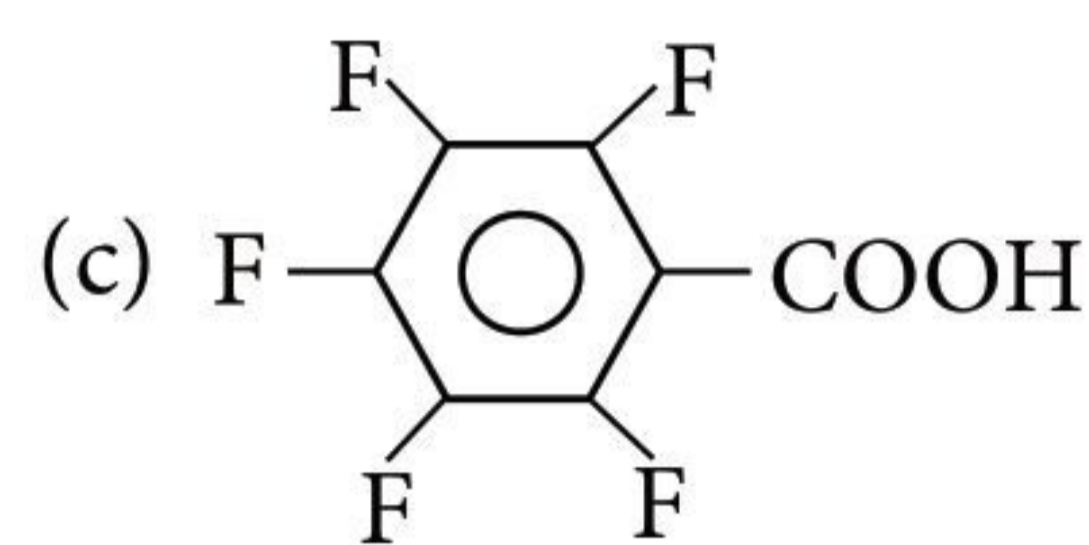
Q. No. 13 and 14 are short answer type II carrying 3 marks each.

13. Given that $E^\circ_{\text{Fe}^{2+}|\text{Fe}} = -0.41 \text{ V}$ and $E^\circ_{\text{Fe}^{3+}|\text{Fe}^{2+}} = 0.77 \text{ V}$, calculate, $E^\circ_{\text{Fe}^{3+}|\text{Fe}}$

14. Identify the more acidic compound in each of the following :



- (b) $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ or $\text{CH}_3\text{C}\equiv\text{CCOOH}$



OR

Suggest a suitable oxidising agent for the conversion :
 $(\text{CH}_3)_2\text{C}=\text{CHCOCH}_3 \longrightarrow (\text{CH}_3)_2\text{C}=\text{CHCOOH}$

For the
SCIENTIST in
YOU

Synthetic chemicals and their role in obesity!!

People are exposed to unnatural chemicals every day, in the form of food additives, disinfectants, pesticides and environmental pollutants. Most are harmless, but some are associated with health concerns and controversies, including some that are linked to obesity – dubbed obesogens.

There has been a recent review which pays particular attention to those chemicals that promote obesity by interfering with the 'endocrine' chemical messaging system, which releases hormones that control metabolism, growth, development and many other aspects of the body's physiology. "The contribution of synthetic chemical exposure to the obesity epidemic remains largely unrecognized," says the corresponding author of the review.

The article surveys the evidence from animal and human studies on the role of environmental obesogens in obesity, the effect of hormone-disrupting chemicals on obesity in different age groups, and the mechanisms of action of the obesogens involved. It also explores strategies to apply more environmentally friendly 'green chemistry' approaches to develop safer alternatives to the chemicals implicated in promoting obesity.

More than 1,000 chemicals have now been identified as environmental obesogens due to their interference of the hormonal system, with many others still being assessed. Those already identified include chemicals regularly found in food, food packaging and in cleaning and disinfecting products. Some are widely known compounds, such as monosodium glutamate, used to enhance the flavour of foods, bisphenols, which can leach into food and drinks from plastic containers and packaging, and organophosphates used in pesticides.

SECTION - D

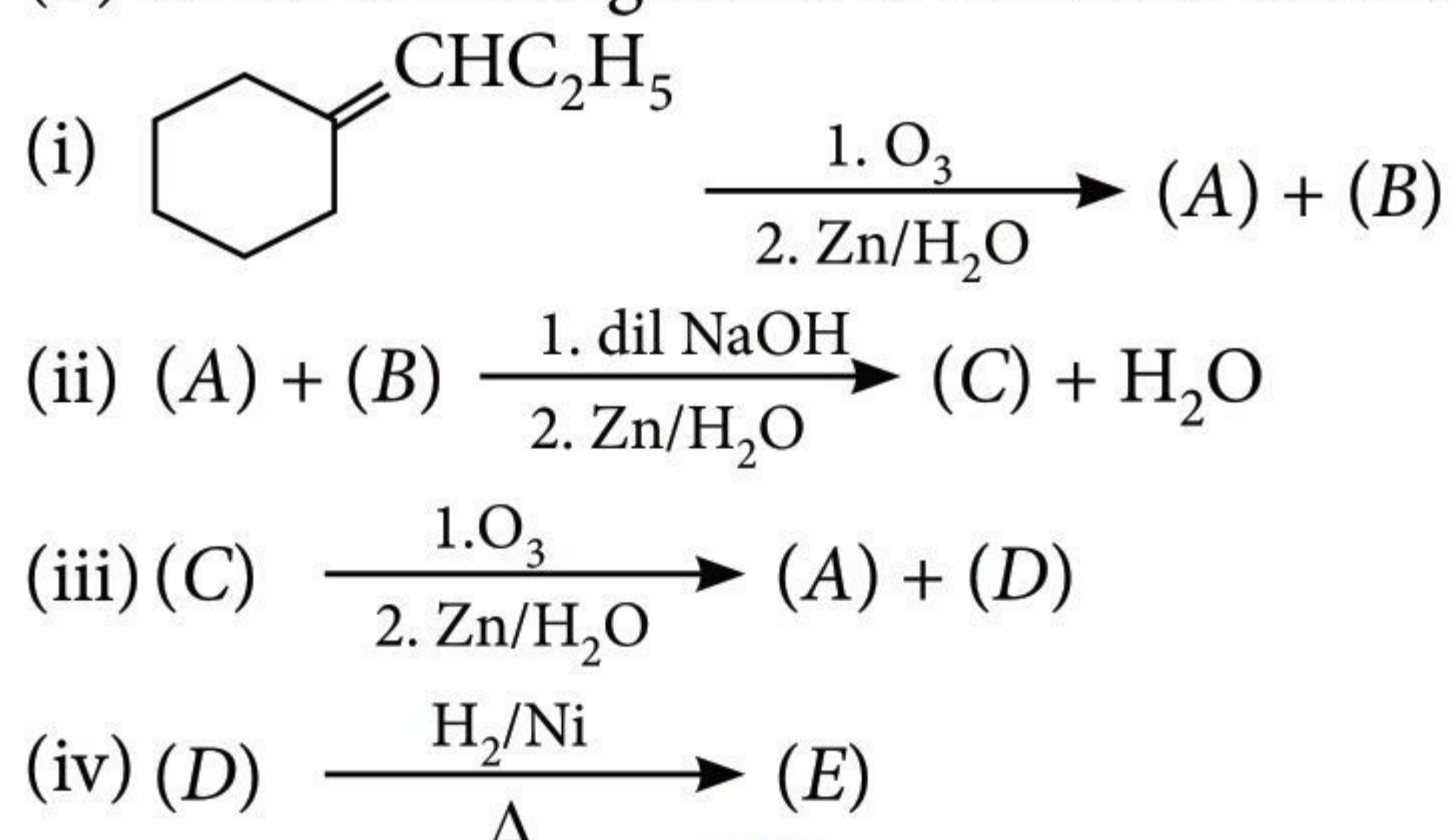
Q. No. 15 and 16 are long answer type carrying 5 marks each.

- 15.** (a) How would you account for the following?
- The atomic radii of the third series of transition elements are virtually the same as those of the corresponding members of the second series.
 - The E° value for $\text{Mn}^{3+}/\text{Mn}^{2+}$ couple is much more positive than that for $\text{Cr}^{3+}/\text{Cr}^{2+}$ couple or $\text{Fe}^{3+}/\text{Fe}^{2+}$ couple.
 - The highest oxidation state of a metal is exhibited in its oxide or fluoride.
- (b) Name the members of the lanthanoid series which exhibit +4 oxidation states and those which exhibit +2 oxidation states. Try to correlate this type of behaviour with the electronic configuration of these elements.

OR

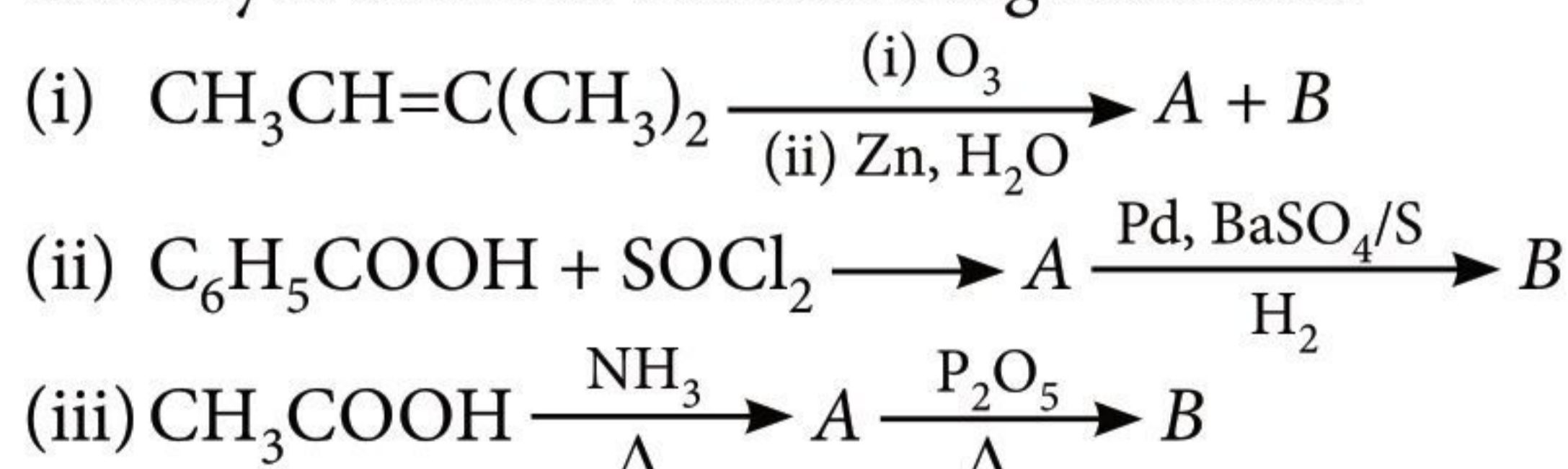
- Why are Sm^{2+} , Eu^{2+} and Yb^{2+} good reducing agents?
 - Can lanthanum ($Z = 57$) exhibit +4 oxidation state?
 - Why are +3 oxidation state of gadolinium ($Z = 64$) and lutetium ($Z = 71$) especially stable?
- (b) What are interstitial compounds? Explain them with reference to transition metals and mention their two important properties.

- 16.** Identify the unknown organic compounds (A) to (E) in the following series of chemical reactions.



OR

Identify A and B in the following reactions.

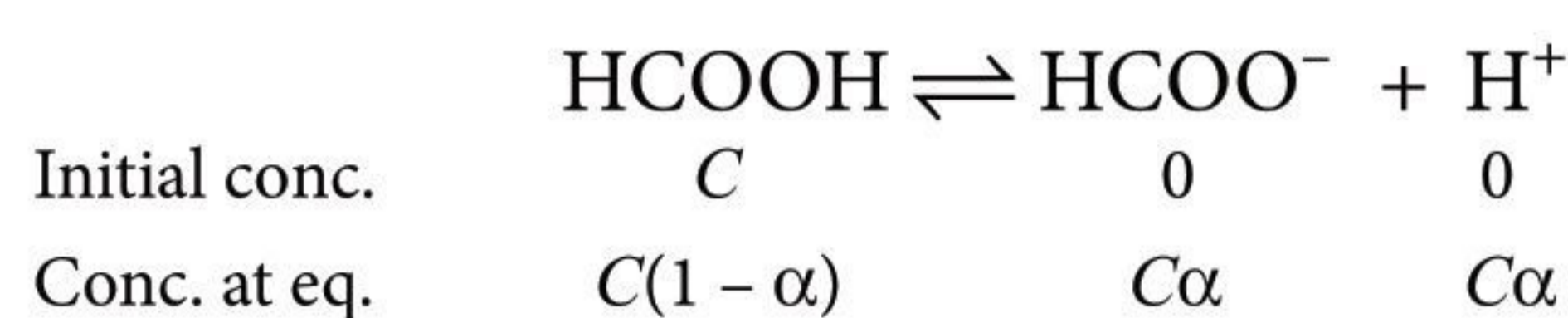


SOLUTIONS

1. (i)(b) : $\Lambda^\circ(\text{HCOOH}) = \lambda^\circ_{(\text{H}^+)} + \lambda^\circ_{(\text{HCOO}^-)}$

$$\alpha = \frac{\Lambda_m^c}{\Lambda_m^\circ} = \frac{46.1}{404.2} = 0.114$$

$$= 349.6 + 54.6 = 404.2 \text{ S cm}^2 \text{ mol}^{-1}$$



$$K_a = \frac{C\alpha \cdot C\alpha}{C(1-\alpha)}$$

$$K_a = \frac{C\alpha^2}{1-\alpha} = \frac{0.025 \times (0.114)^2}{1-0.114} = 3.67 \times 10^{-4}$$

(ii) (b) : $\Lambda^\circ_{m(\text{NH}_4\text{OH})} = \lambda^\circ_{\text{NH}_4^+} + \lambda^\circ_{\text{OH}^-}$

$$= \Lambda^\circ_{m(\text{NH}_4\text{Cl})} + \frac{1}{2} \Lambda^\circ_{m(\text{BaOH})_2} - \frac{1}{2} \Lambda^\circ_{m(\text{BaCl}_2)}$$

$$= 129.8 + \frac{1}{2} (461) - \frac{1}{2} (240.6)$$

$$= 129.8 + 230.5 - 120.3 = 240 \text{ } \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

(iii)(d) : Degree of dissociation (α)

$$= \frac{\Lambda_m^c}{\Lambda_m^\circ} = \frac{9.6}{240} = 0.04 = 4\%$$

(iv) (a)

OR

(b) $\Lambda_m = \frac{1000 \text{ cm}^3 \times \kappa}{0.0005 \text{ mol}}$

$$= \frac{1000 \text{ cm}^3 \times 134.3 \times 10^{-6} \text{ S cm}^{-1}}{0.0005 \text{ mol}}$$

$$= 268.6 \text{ S cm}^2 \text{ mol}^{-1}$$

2. (d) : Λ_m vs \sqrt{C} curves are hyperbolic for weak electrolytes because on dilution number of ions as well as ionic mobility both increase for weak electrolytes.

3. (d) : Ionic radii in +3 oxidation state in (pm) is the following :

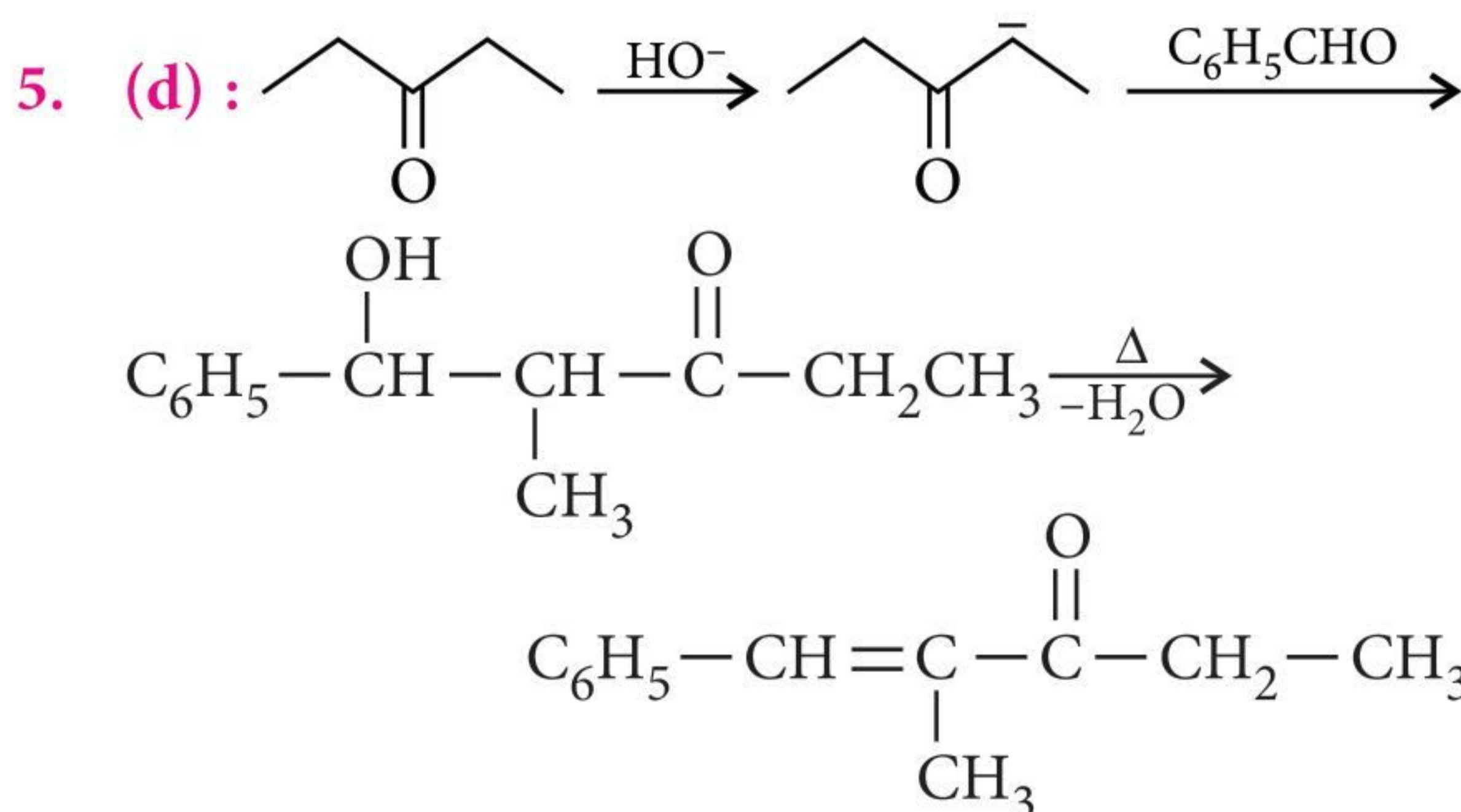
Yb	Pm	Ce	La
86.8	97	102	103

OR

(d) : Most of the transition elements show variety of oxidation states in their compounds.

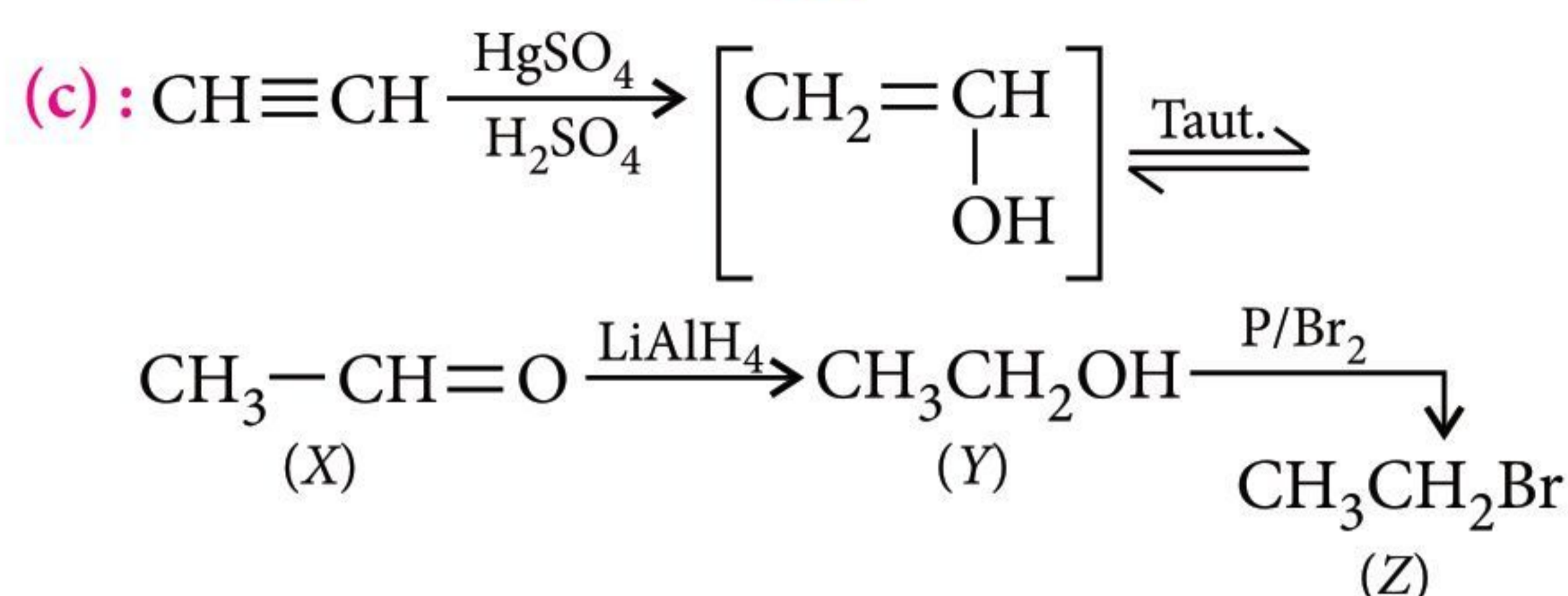
4. (c) : $E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$

$$= 0.15 - (-0.74) = +0.89 \text{ V}$$



6. (a)

OR



7. (c)

OR

(a) : The element which can reduce itself acts as an oxidising agent.

8. (c) : Energy gap between $4f$, $5d$ and $6s$ is large thus lanthanoids show limited number of oxidation states, whereas that between $5f$, $6d$ and $7s$ is small. Thus, actinoids show large number of oxidation states.

9. When 99.99% of Cu^{2+} is consumed, its concentration decreases by 0.9999 (from 1 M to 0.0001 M) and the Zn^{2+} ion concentration increases by 0.9999 (From 1 M to 1.9999 M.)

From the Nernst equation,

$$\begin{aligned} E &= E^\circ - \frac{0.0592}{n} \log Q = 1.10 - \frac{0.0592}{2} \log \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \\ &= 1.10 - \frac{0.0592}{2} \log \frac{1.9999}{0.0001} \\ &= 1.10 - \frac{0.0592}{2} \log(1.9999 \times 10^4) \\ &= 1.10 - 0.0296(4 + 0.301) = 0.97 \text{ V} \end{aligned}$$

OR

According to the Nernst equation,

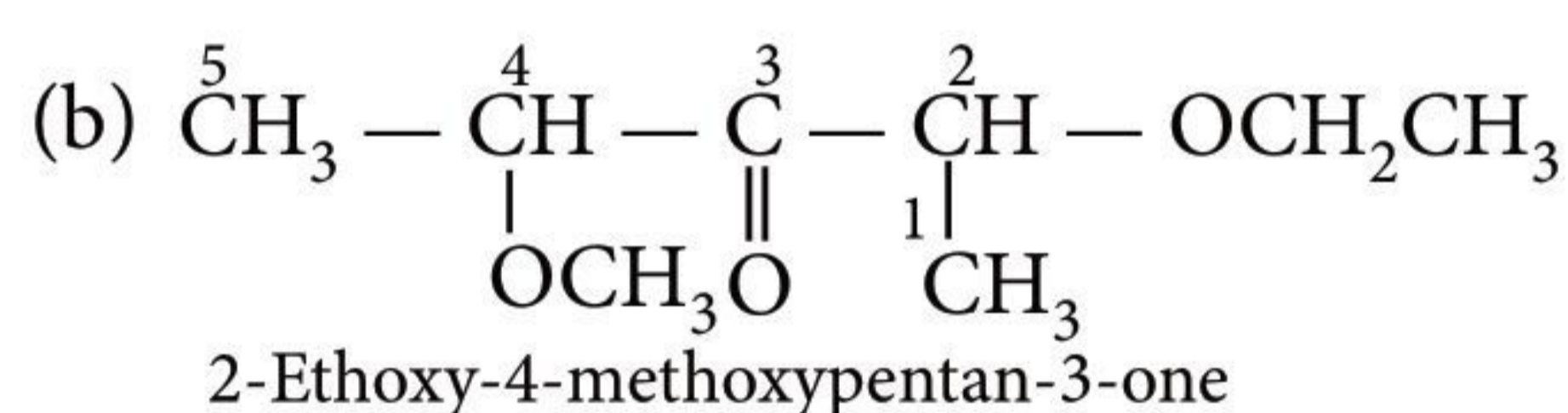
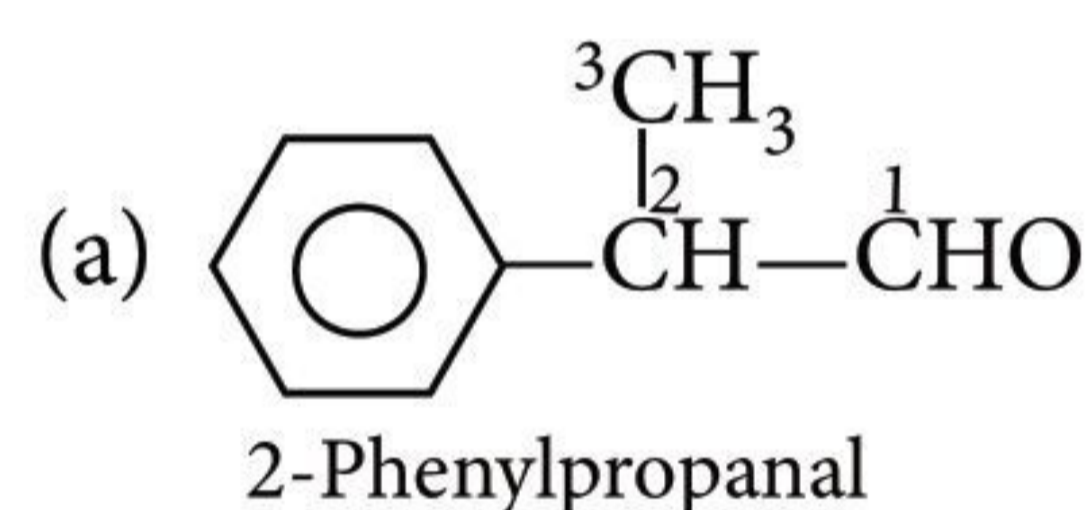
$$\begin{aligned} E_{\text{Zn}^{2+}|\text{Zn}} &= E_{\text{Zn}^{2+}|\text{Zn}}^\circ - \frac{RT}{2F} \ln \frac{1}{[\text{Zn}^{2+}]} \\ &= E_{\text{Zn}^{2+}|\text{Zn}}^\circ - \frac{0.0592}{2} \log \frac{1}{[\text{Zn}^{2+}]} \\ &= -0.76 - \frac{0.059}{2} \log \frac{1}{0.001} = -0.76 - \frac{0.0592}{2} \log 10^3 \\ &= -0.76 - \frac{3 \times 0.0592}{2} = -0.85 \text{ V} \end{aligned}$$

10. ScO_2^- : Group number = Oxidation state of Sc = 3
 TiO_3^{2-} : Group number = Oxidation state of Ti = 4
 VO_3^- : Group number = Oxidation state of V = 5
 $\text{Cr}_2\text{O}_7^{2-}$: Group number = Oxidation state of Cr = 6
 CrO_4^{2-} : Group number = Oxidation state of Cr = 6
 MnO_4^- : Group number = Oxidation state of Mn = 7

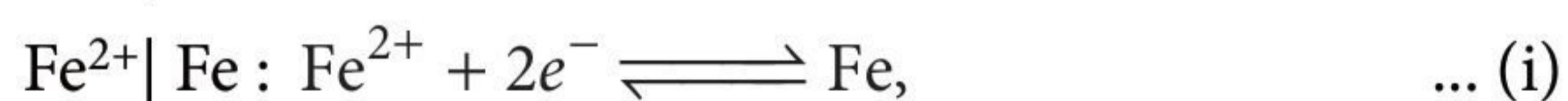
11. Atomic number (61) = $_{54}[\text{Xe}] 4f^5 6s^2$
 Atomic number (91) = $_{86}[\text{Rn}] 5f^2 6d^1 7s^2$
 Atomic number (101) = $_{86}[\text{Rn}] 5f^{13} 7s^2$
 Atomic number (109) = $_{86}[\text{Rn}] 5f^{14} 6d^7 7s^2$

12. The molecular masses of these compounds are comparable, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO} = 72$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} = 74$, $\text{C}_2\text{H}_5-\text{O}-\text{C}_2\text{H}_5 = 74$, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 = 72$. Among these compounds, butan-1-ol, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ molecules are associated because of extensive intermolecular hydrogen bonding, therefore, its boiling point would be the highest. Butanal, $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$ is more polar than ethoxyethane, $\text{C}_2\text{H}_5-\text{O}-\text{C}_2\text{H}_5$. The intermolecular dipole-dipole attractions are stronger in butanal in comparison to ethoxyethane and hence the boiling point of $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$ is higher than that of $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$. n -Pentane molecules have only weak van der Waals forces of attraction which are weaker than some dipole-dipole interactions in $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$. Hence, boiling point of $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$ is slightly higher than that of n -pentane. Thus, increasing order of boiling points of these compounds is : $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 < \text{C}_2\text{H}_5\text{OC}_2\text{H}_5 < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO} < \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

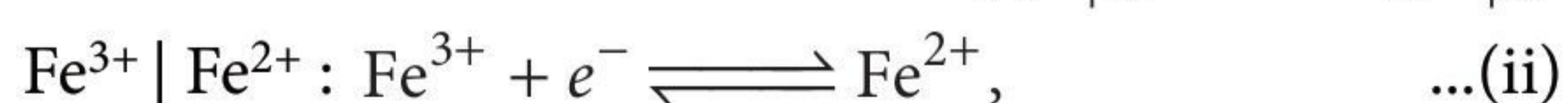
OR



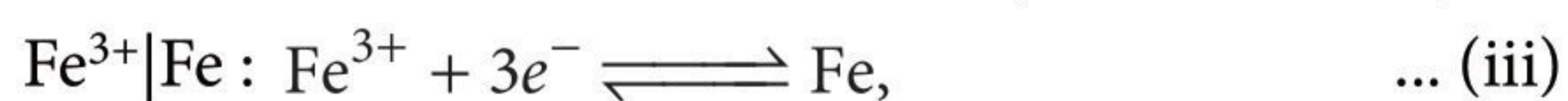
13. The electrode reactions at the $\text{Fe}^{2+}|\text{Fe}$, $\text{Fe}^{3+}|\text{Fe}^{2+}$ and $\text{Fe}^{3+}|\text{Fe}$ electrodes are as follows:



$$\Delta G_{\text{Fe}^{2+}|\text{Fe}}^\circ = -2FE_{\text{Fe}^{2+}|\text{Fe}}^\circ$$



$$\Delta G_{\text{Fe}^{3+}|\text{Fe}^{2+}}^\circ = -FE_{\text{Fe}^{3+}|\text{Fe}^{2+}}^\circ$$



$$\Delta G_{\text{Fe}^{3+}|\text{Fe}}^\circ = -3FE_{\text{Fe}^{3+}|\text{Fe}}^\circ$$

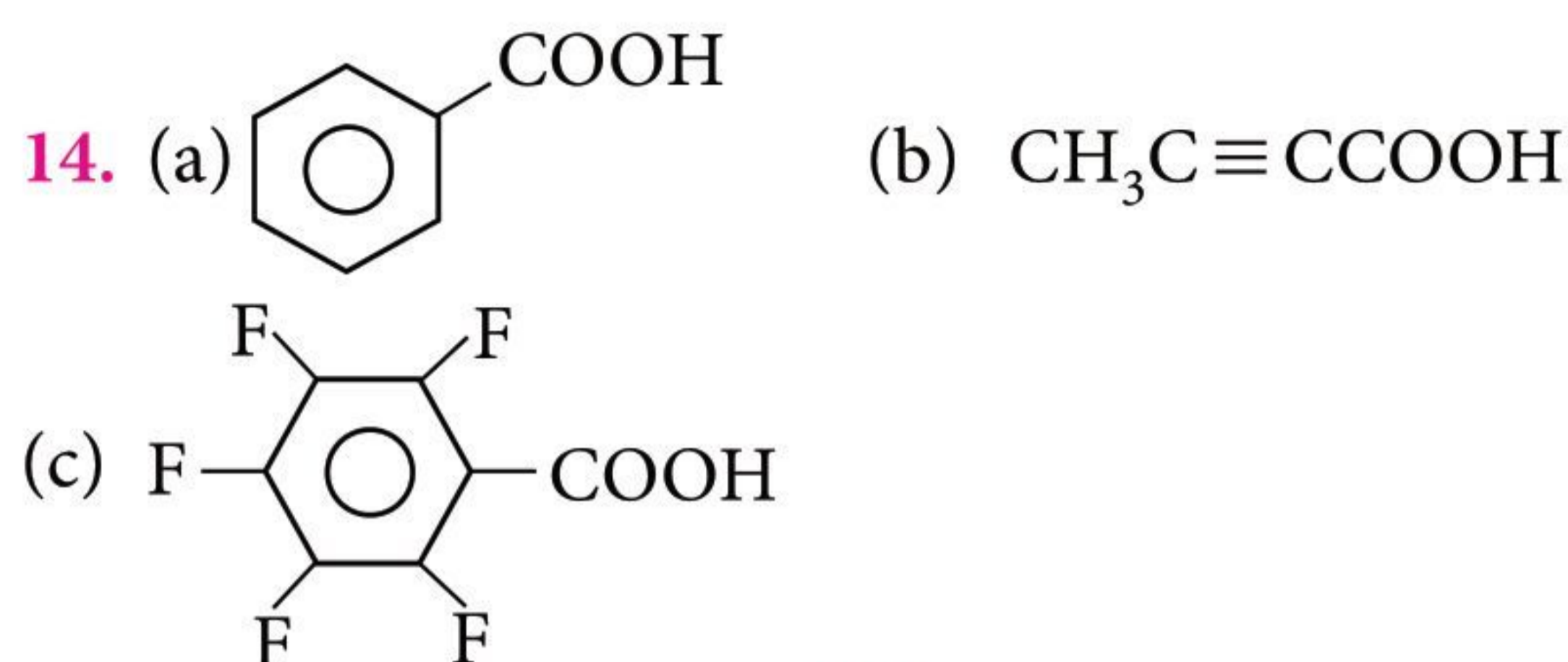
\therefore equation (iii) = equation (i) + equation (ii),

$$\Delta G_{\text{Fe}^{3+}|\text{Fe}}^\circ = \Delta G_{\text{Fe}^{2+}|\text{Fe}}^\circ + \Delta G_{\text{Fe}^{3+},\text{Fe}^{2+}}^\circ$$

$$\Rightarrow -3FE_{\text{Fe}^{3+}|\text{Fe}}^\circ = -2FE_{\text{Fe}^{2+}|\text{Fe}}^\circ - FE_{\text{Fe}^{3+}|\text{Fe}^{2+}}^\circ$$

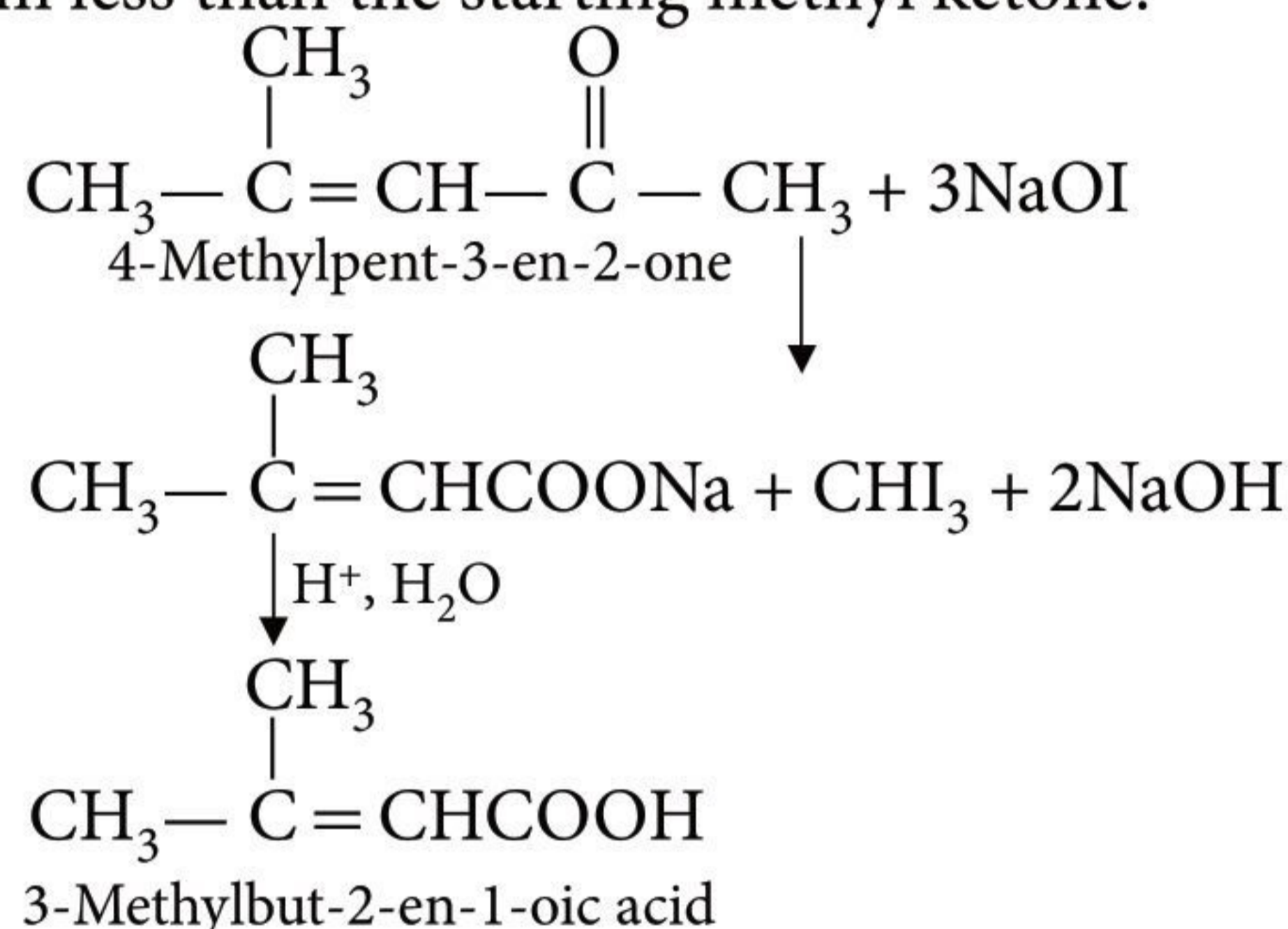
$$\Rightarrow E_{\text{Fe}^{3+}|\text{Fe}}^\circ = \frac{2E_{\text{Fe}^{2+}|\text{Fe}}^\circ + E_{\text{Fe}^{3+}|\text{Fe}^{2+}}^\circ}{3}$$

$$= \frac{2 \times (-0.41 \text{ V}) + 0.77 \text{ V}}{3} = -\frac{0.05 \text{ V}}{3} = -0.0167 \text{ V}$$



OR

Alkaline KMnO_4 or acidified $\text{K}_2\text{Cr}_2\text{O}_7$ or HNO_3 cannot be used because all of these will result into cleavage of the molecule at the site of double bond giving a mixture of ketones or acids. The best reagent for oxidation is NaOI (I_2/NaOH) because methyl ketones on treatment with NaOI undergo iodoform reaction forming iodoform and sodium salt of carboxylic acid having one carbon atom less than the starting methyl ketone.



15. (a)(i) The atomic radii of the third series of transition elements are virtually the same as those of the corresponding members of the second series due to lanthanoid contraction.

(ii) $\text{Mn}^{3+}(3d^4)$ is less stable than $\text{Mn}^{2+}(3d^5)$ which has stable half-filled configuration. $\text{Fe}^{3+}(3d^5)$ is more stable than $\text{Fe}^{2+}(3d^6)$ due to half-filled configuration. Cr^{3+} has stable t_{2g}^3 configuration. So, E° value for the $\text{Mn}^{3+}/\text{Mn}^{2+}$ couple is much more positive.

(iii) The highest oxidation state of a metal is exhibited in its oxide or fluoride. Due to the high electronegativity and small size of oxygen and fluorine.

(b) +4 oxidation state : Cerium (Ce), Neodymium (Nd), Praseodymium (Pr), Terbium (Tb),

+2 oxidation state : Samarium (Sm), Europium (Eu), Thulium (Tm) and Ytterbium (Yb)

+4 and +2 oxidation states of lanthanoid elements arise mainly from the extra stability of empty, half-filled and fully-filled f -subshells. For example, Ce (IV) is $4f^0$ and has noble gas configuration. Similarly, Tb (IV) and Eu (II) have $4f^7$ configuration. Yb(II) has $4f^{14}$ configuration.

OR

(a) (i) The most stable oxidation state of lanthanides is +3. Hence, ions in +2 state tend to change to +3 oxidation state by loss of electron and act as reducing agents.

(ii) La^{3+} has a stable configuration of an inert gas $[\text{Xe}]5d^06s^0$. To obtain +4 oxidation state, the stable configuration is to be disturbed which is not possible under ordinary conditions and hence, La^{4+} does not exist.

(iii) This is because gadolinium in +3 oxidation state has half filled $4f$ -subshell ($4f^7$) and lutetium in +3 oxidation state has completely filled $4f$ -subshell ($4f^{14}$) which are very stable configurations.

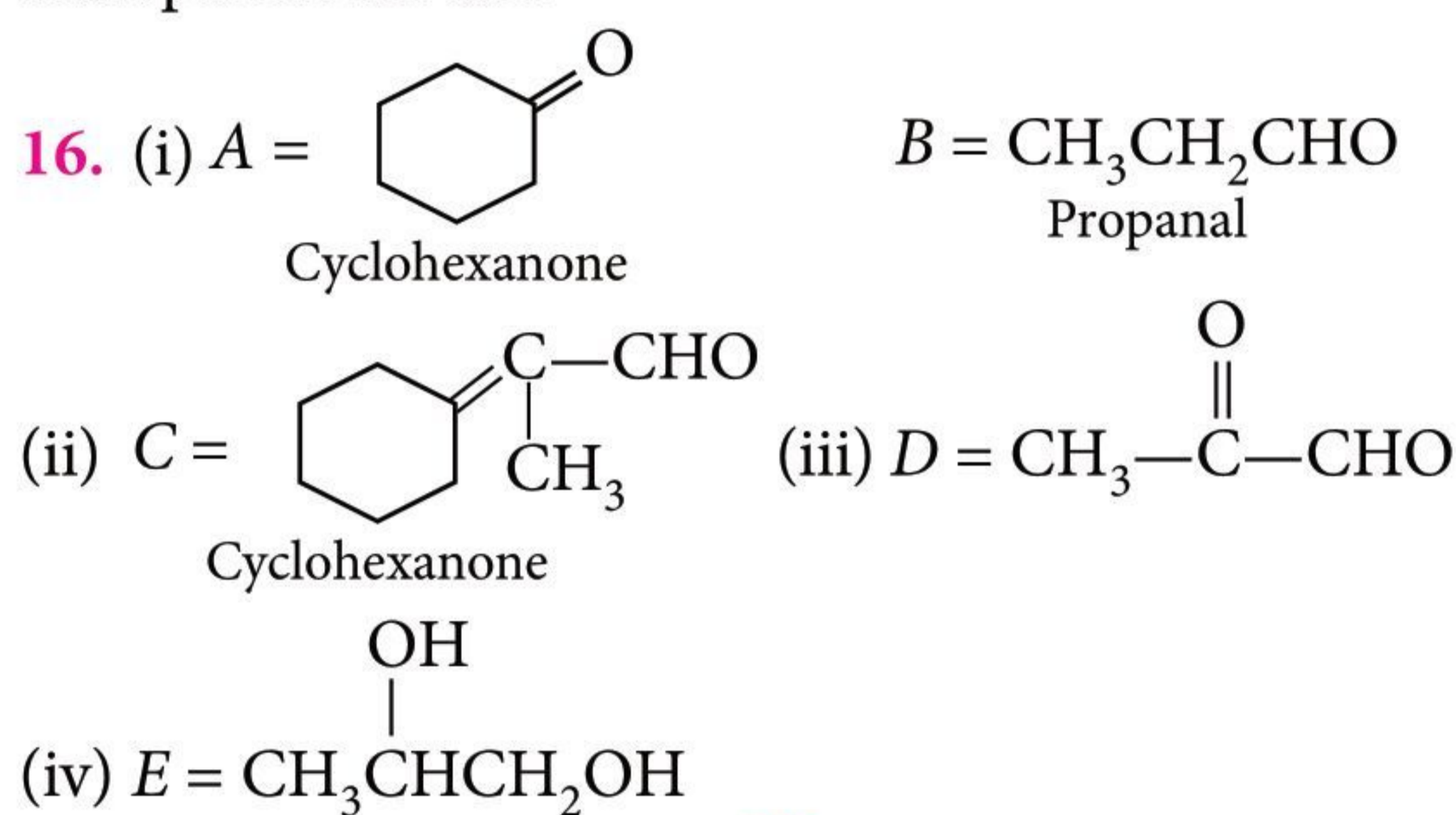
(b) Small atoms like B, C, N, etc., can occupy positions in the voids among the atoms of transition metals. Such combinations are termed as interstitial compounds. They are usually non-stoichiometric materials having formulae like $\text{VH}_{0.56}$, $\text{TiH}_{1.7}$, TiC , etc.

Steel is an interstitial compound in which voids among iron atoms are occupied by carbon atoms.

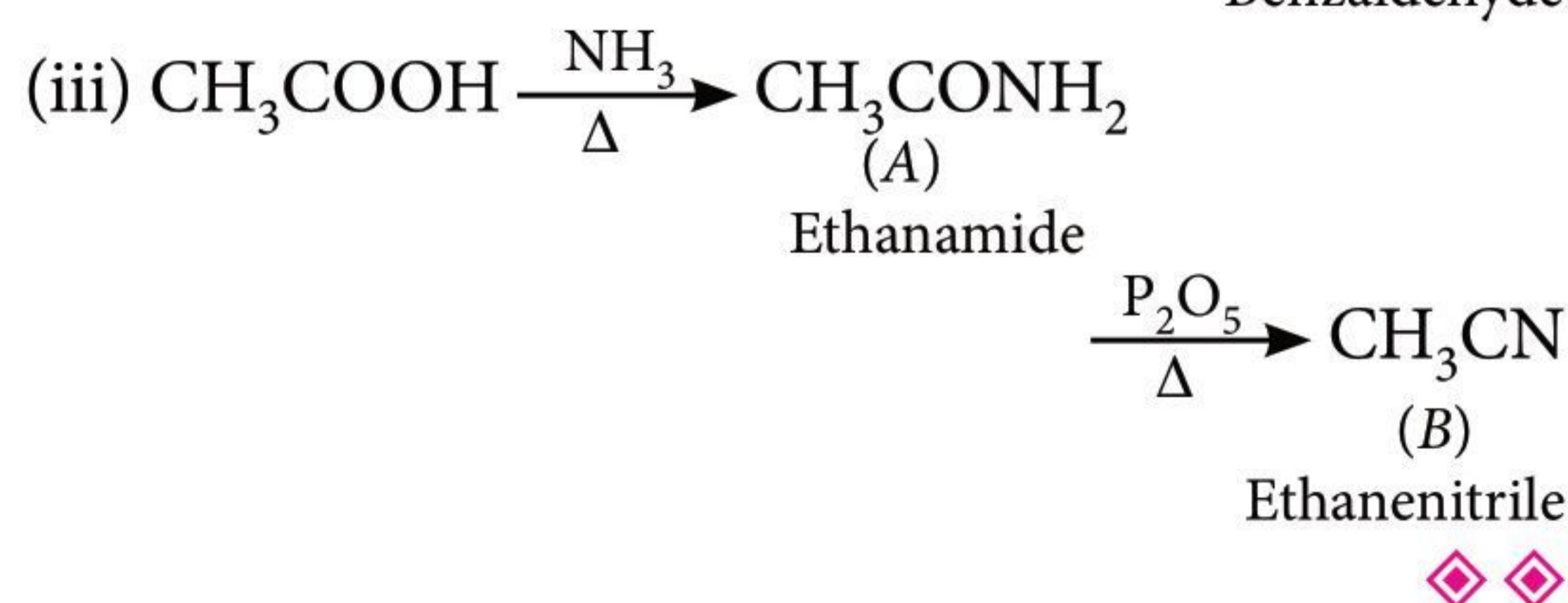
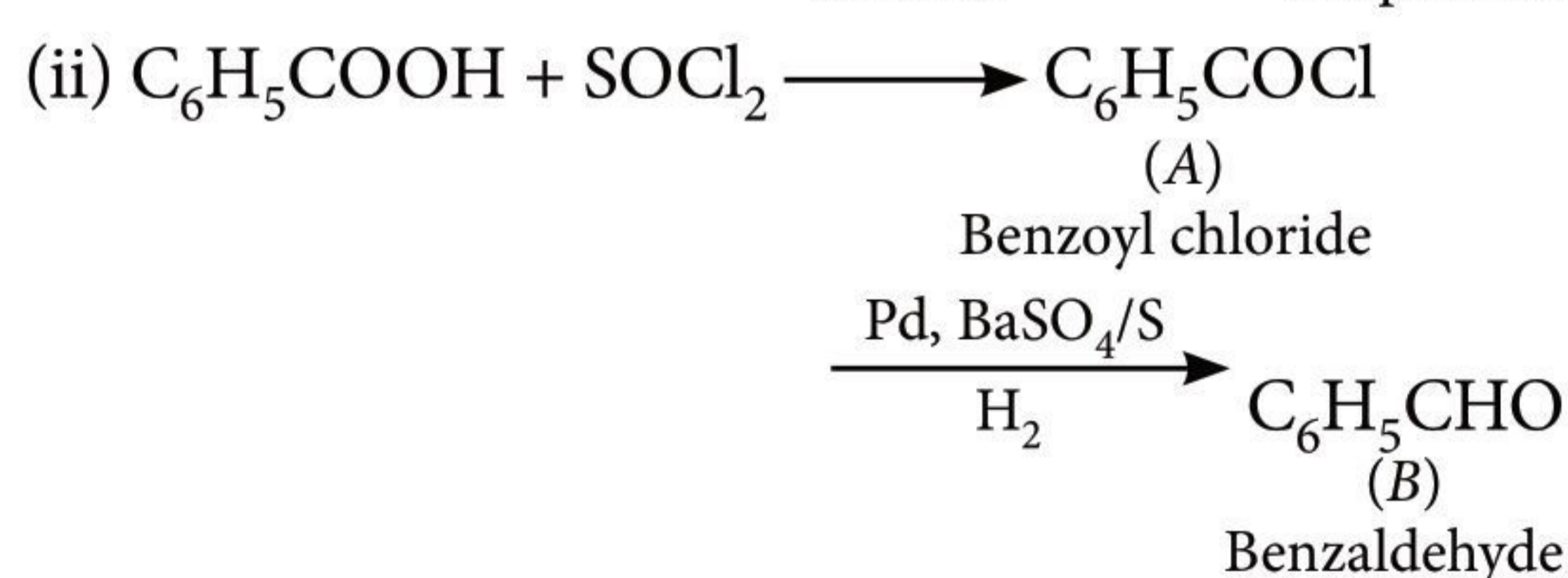
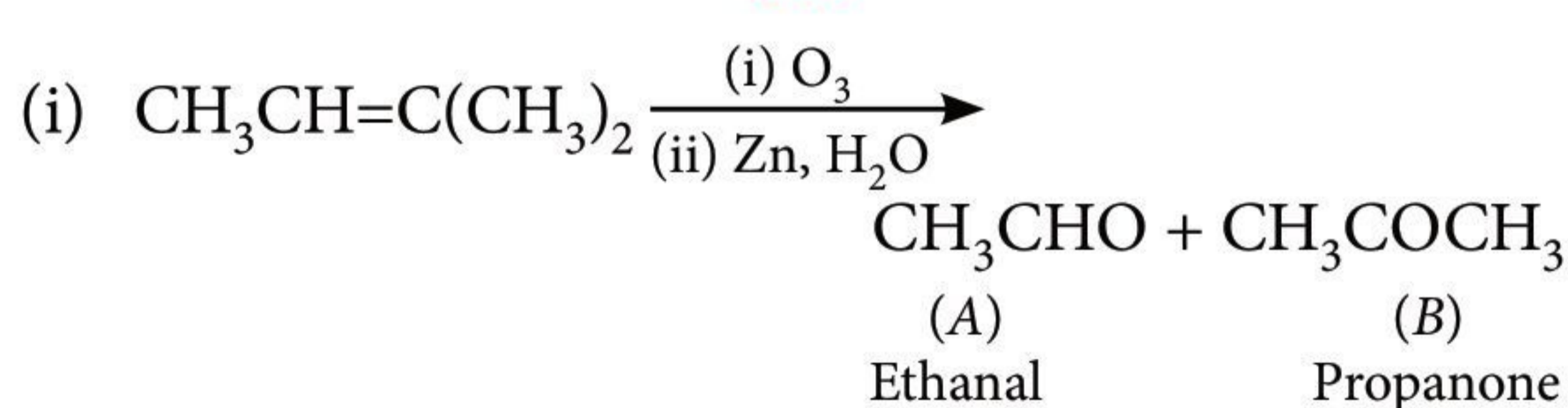
Two important properties :

(i) Transition metals become more harder and rigid.

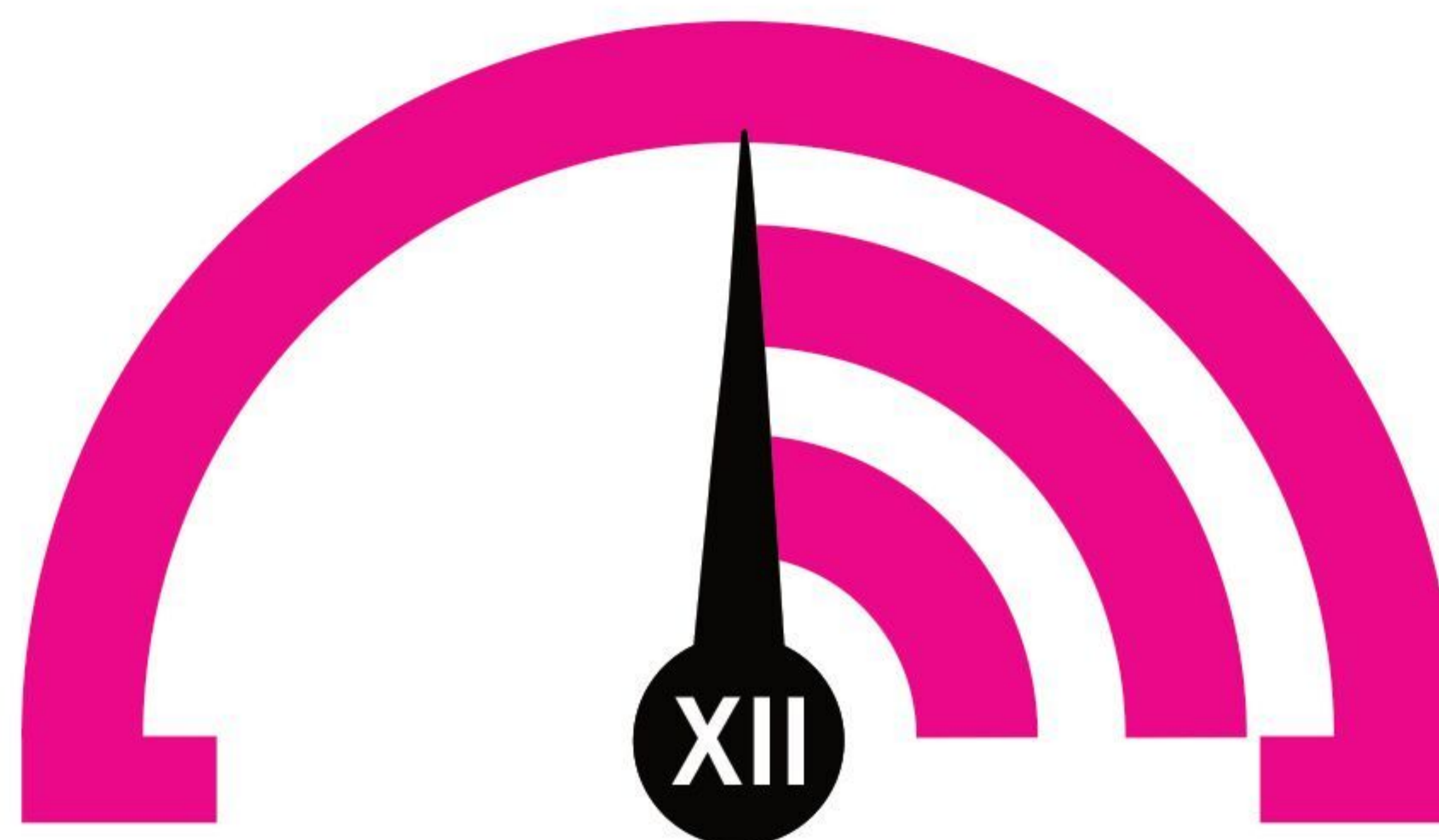
(ii) Melting points of interstitial compounds are higher than parent metals.



OR



MONTHLY TEST DRIVE



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Total Marks : 120

d- & *f*-Block Elements | Coordination Compounds

Time Taken : 60 Min.

NEET

Only One Option Correct Type

- Which of the following reactions are disproportionation reactions?
 - $\text{Cu}^+ \longrightarrow \text{Cu}^{2+} + \text{Cu}$
 - $3\text{MnO}_4^{2-} + 4\text{H}^+ \longrightarrow 2\text{MnO}_4^- + \text{MnO}_2 + 2\text{H}_2\text{O}$
 - $2\text{KMnO}_4 \longrightarrow \text{K}_2\text{MnO}_4 + \text{MnO}_2 + \text{O}_2$
 - $2\text{MnO}_4^- + 3\text{Mn}^{2+} + 2\text{H}_2\text{O} \longrightarrow 5\text{MnO}_2 + 4\text{H}^+$
 - only i, ii
 - only i, ii, iii
 - only ii, iii, iv
 - only i, iv
- Highest oxidation state of manganese in fluorides is +4 (MnF_4) but highest oxidation state in oxides is +7 (Mn_2O_7) because _____.
 - fluorine is more electronegative than oxygen
 - fluorine does not possess *d*-orbitals
 - fluorine stabilises lower oxidation state
 - in covalent compounds fluorine can form single bonds only while oxygen forms double bonds.
- Which is not the correct naming?
 - Potassium tetrahydroxozincate(II)
- $\text{K}_2[\text{Zn}(\text{OH})_4]$
 - Potassium pentacyanonitrito ferrate(II)
- $\text{K}_3[\text{Fe}(\text{CN})_5\text{NO}]$
 - Tetraammineaquachloridocobalt(III)
chloride- $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]\text{Cl}_2$
 - Dichloridobis(ethane-1, 2-diamine)cobalt (III)
ion - $[\text{CoCl}_2(\text{en})_2]^+$
- Which of the following is expected to be a paramagnetic complex?
 - $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
 - $[\text{Ni}(\text{CO})_4]$
 - $[\text{Zn}(\text{NH}_3)_4]^{2+}$
 - $[\text{Co}(\text{NH}_3)_6]^{3+}$
- In an alkaline medium, KMnO_4 oxidizes I^- ions to give
 - a brown solution containing I_3^- ions accompanied by the precipitation of MnO_2 (brown)
 - a colourless solution containing IO_3^- ions accompanied by the precipitation of MnO_2 (brown)
 - a colourless solution containing IO^- and Mn^{2+} ions
 - a colourless solution containing IO_3^- and Mn^{2+} ions.
- In which of the following coordination entities the magnitude of Δ_o (CFSE in octahedral field) will be maximum?
 - $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$
 - $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
 - $[\text{Co}(\text{NH}_3)_6]^{3+}$
 - $[\text{Co}(\text{CN})_6]^{3-}$
- On being heated at 100°C , 1 mol of a hydrate isomer A of $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$ loses 6.75% mass and the other isomer B, 13.50% mass. A and B are, respectively,
 - $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ and $[\text{CrCl}(\text{H}_2\text{O})_5]\text{Cl}_2 \cdot \text{H}_2\text{O}$
 - $[\text{CrCl}(\text{H}_2\text{O})_5]\text{Cl}_2 \cdot \text{H}_2\text{O}$ and $[\text{CrCl}_2(\text{H}_2\text{O})_4]\text{Cl} \cdot 2\text{H}_2\text{O}$
 - $[\text{CrCl}_2(\text{H}_2\text{O})_4]\text{Cl} \cdot 2\text{H}_2\text{O}$ and $[\text{CrCl}(\text{H}_2\text{O})_5]\text{Cl}_2 \cdot \text{H}_2\text{O}$
 - $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ and $[\text{CrCl}_2(\text{H}_2\text{O})_4]\text{Cl}_2 \cdot 2\text{H}_2\text{O}$
- Which of the following statements is correct?
 - For a given set of *M*, *L* and *M* — *L* distance,
 $\Delta_o \approx \frac{4}{9} \Delta_t$.
 - The successive stability constant values of the complexes of a given metal ion with a ligand generally decrease.
 - Oxalato complexes of transition metals are organometallic compounds.
 - Square-planar coordination species containing four different ligands exhibit optical isomerism.
- Which complex compound obeys 18-electron rule?
 - $[\text{V}(\text{CO})_5]$
 - $[\text{Fe}(\text{NH}_3)_6]^{2+}$
 - $[\text{Ni}(\text{CO})_6]$
 - $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$

10. Among the following groups of transition metal ions, the one where all metal ions have $3d^2$ electronic configuration is
 (a) $Ti^{3+}, V^{2+}, Cr^{3+}, Mn^{4+}$ (b) $Ti^{+}, V^{4+}, Cr^{6+}, Mn^{7+}$
 (c) $Ti^{4+}, V^{3+}, Cr^{2+}, Mn^{3+}$ (d) $Ti^{2+}, V^{3+}, Cr^{4+}, Mn^{5+}$
11. The complex ion which has three 'd' electrons in the central metal atom is
 (a) $[MnO_4]^{-}$ (b) $[Co(NH_3)_6]^{3+}$
 (c) $[Fe(CN)_6]^{3-}$ (d) $[Cr(H_2O)_6]^{3+}$
12. Which of the following complexes formed by Cu^{2+} ions is most stable?
 (a) $Cu^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+}; \log K = 11.6$
 (b) $Cu^{2+} + 4CN^{-} \rightleftharpoons [Cu(CN)_4]^{2-}; \log K = 27.3$
 (c) $Cu^{2+} + 2en \rightleftharpoons [Cu(en)_2]^{2+}; \log K = 15.4$
 (d) $Cu^{2+} + 4H_2O \rightleftharpoons [Cu(H_2O)_4]^{2+}; \log K = 8.9$

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) If assertion is true but reason is false.
 (d) If both assertion and reason are false.

13. **Assertion :** TiF_4 , VF_5 and CrF_6 are stable.
Reason : The covalent M-F bond has high bond enthalpy.

14. **Assertion :** The geometrical isomers of $[M(NH_3)_4Cl_2]$ are optically inactive.
Reason : Both geometrical isomers of $[M(NH_3)_4Cl_2]$ possess an axis of symmetry.

15. **Assertion :** Tetrahedral complexes having two different types of unidentate ligands coordinated with central metal ion will show geometrical isomerism.
Reason : Geometrical isomerism arises in homoleptic complexes due to different possible geometric arrangements of the ligands.

JEE MAIN / JEE ADVANCED

Only One Option Correct Type

16. Consider the following statements :
 (I) $La(OH)_3$ is the least basic among hydroxides of lanthanides.
 (II) Zr^{4+} and Hf^{4+} possess almost the same ionic radii.
 (III) Ce^{4+} can act as an oxidizing agent.
 Which of the above is/are true?

- (a) (I) and (III) (b) (II) and (III)
 (c) (II) only (d) (I) and (II)

17. A solution of a metal ion when treated with KI gives a red precipitate which dissolves in excess of KI to give a colourless solution. Moreover, the solution of metal ion on treatment with a solution of cobalt(II) thiocyanate gives rise to deep blue crystalline precipitate. The metal ion is
 (a) Pb^{2+} (b) Hg^{2+} (c) Cu^{2+} (d) Co^{2+}

18. The two isomers X and Y with the formula $Cr(H_2O)_5ClBr_2$ were taken for an experiment on depression in freezing point. It was found that one mole of X gave depression corresponding to 2 moles of particles and one mole of Y gave depression due to 3 moles of particles. The structural formulae of X and Y respectively are
 (a) $[Cr(H_2O)_5Cl]Br_2; [Cr(H_2O)_3ClBr_2] \cdot 2H_2O$
 (b) $[Cr(H_2O)_5Br]BrCl; [Cr(H_2O)_4ClBr]Br \cdot H_2O$
 (c) $[Cr(H_2O)_5Cl]Br_2; [Cr(H_2O)_4ClBr]Br \cdot H_2O$
 (d) $[Cr(H_2O)_4Br_2]Cl \cdot H_2O; [Cr(H_2O)_5Cl]Br_2$

19. In acidic medium, $KMnO_4$ oxidises $FeSO_4$ solution. Which of the following statements is correct?
 (a) 10 mL of 1 N $KMnO_4$ solution oxidises 10 mL of 5 N $FeSO_4$ solution.
 (b) 10 mL of 1 M $KMnO_4$ solution oxidises 10 mL of 5 M $FeSO_4$ solution.
 (c) 10 mL of 1 M $KMnO_4$ solution oxidises 10 mL of 1 M $FeSO_4$ solution.
 (d) 10 mL of 1 N $KMnO_4$ solution oxidises 10 mL of 0.1 M $FeSO_4$ solution.

More than One Option Correct Type

20. Although +3 is the characteristic oxidation state for lanthanoids but cerium also shows +4 oxidation state because _____.
 (a) it has variable ionisation enthalpy
 (b) it has a tendency to attain noble gas configuration
 (c) it has a tendency to attain f^0 configuration
 (d) it resembles Pb^{4+} .
21. Which of the following statements are correct with reference to ferrous and ferric ions?
 (a) Fe^{3+} gives brown colour with potassium ferricyanide.
 (b) Fe^{2+} gives blue precipitate with potassium ferricyanide.
 (c) Fe^{3+} gives red colour with potassium thiocyanate.
 (d) Fe^{2+} gives brown colour with potassium thiocyanate.

22. Which of the following are outer orbital complexes?
 (a) $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ (b) $[\text{CoF}_6]^{3-}$
 (c) $[\text{Fe}(\text{CN})_6]^{4-}$ (d) $[\text{Fe}(\text{CN})_6]^{3-}$

23. Which of the following give the correct order of Δ ?
 (a) $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} < [\text{Cr}(\text{en})_3]^{3+}$
 (b) $[\text{Cr}(\text{NH}_3)_6]^{3+} < [\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
 (c) $[\text{Co}(\text{NH}_3)_6]^{2+} < [\text{Fe}(\text{CN})_6]^{4-}$
 (d) $[\text{Pt}(\text{NH}_3)_6]^{4+} < [\text{Pt}(\text{dipy})_3]^{4+}$

Integer / Numerical Value Type

24. The number of paramagnetic ion(s) among Ti^{3+} , Cr^{3+} , Ti^{4+} , Fe^{2+} , Co^{2+} , Zn^{2+} , Cu^+ , V^{3+} , Mn^{2+} is (are)
 25. If chloride ions satisfy all the primary valencies of cobalt then, the total number of ions formed due to ionisation of the compound $\text{CoCl}_3 \cdot 6\text{H}_2\text{O}$ is
 26. In the coordination compound, $\text{K}_4[\text{Ni}(\text{CN})_4]$, the oxidation state of nickel is

Comprehension Type

A mineral, on being roasted with Na_2CO_3 , gives a solid mixture, which when digested with water, gives a yellow solution (A) and a brown residue (B). The solution (A) is treated with H_2SO_4 so that it is completely changed into an orange compound (C) from which a white substance separates on cooling. On removal of the white solid, the solution is heated and treated with KCl. The mixture, on being cooled, yields an orange solid (D).

When a mixture containing the crystals of D and NaCl is warmed with concentrated H_2SO_4 , red vapours of the substance (E) are evolved, which turns NaOH solution yellow, due to formation of the compound (F).

The residue (B) is extracted with dilute HCl and the extract, when treated with a $\text{K}_4[\text{Fe}(\text{CN})_6]$ solution, gives an intense blue precipitate (G).

27. The oxidation states of the central atom in D, E and F are, respectively,
 (a) +3, +3, and +3 (b) +3, +6, and +3
 (c) +3, +6, and +6 (d) +6, +6, and +6
 28. Which of the following would have been evolved, had the crystals (D) been heated with NaBr and concentrated H_2SO_4 ?

- (a) CrO_2Br_2 (b) Br_2
 (c) HBr (d) $\text{HBr} + \text{Br}_2$

Matrix Match Type

29. Match the entries listed in Column I with appropriate entries listed in Column II.

Column I	Column II
(A) $\text{K}_2\text{MnO}_4(\text{aq})$	(i) purple colour discharged when treated with Fe^{2+}
(B) $\text{KMnO}_4(\text{aq})$	(ii) orange, turning yellow when treated with an alkali
(C) $\text{K}_2\text{CrO}_4(\text{aq})$	(iii) green, turning purple when treated with Cl_2
(D) $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$	(iv) yellow, turning orange when treated with an acid

A	B	C	D
(a) (ii)	(iii)	(iv)	(i)
(b) (iii)	(ii)	(iv)	(i)
(c) (i)	(iii)	(iv)	(ii)
(d) (iii)	(i)	(iv)	(ii)

30. Match the lists I and II and pick the correct matching from the codes given below.

List I	List II
(A) $[\text{Ag}(\text{CN})_2]^-$	1. Square planar and 1.73 B.M.
(B) $[\text{Cu}(\text{CN})_4]^{3-}$	2. Linear and zero
(C) $[\text{Cu}(\text{CN})_6]^{4-}$	3. Octahedral and zero
(D) $[\text{Cu}(\text{NH}_3)_4]^{2+}$	4. Tetrahedral and zero
(E) $[\text{Fe}(\text{CN})_6]^{4-}$	5. Octahedral and 1.73 B.M.
(a) A – 2, B – 4, C – 5, D – 1, E – 3	
(b) A – 5, B – 4, C – 1, D – 3, E – 2	
(c) A – 1, B – 3, C – 4, D – 2, E – 5	
(d) A – 4, B – 5, C – 2, D – 1, E – 3	



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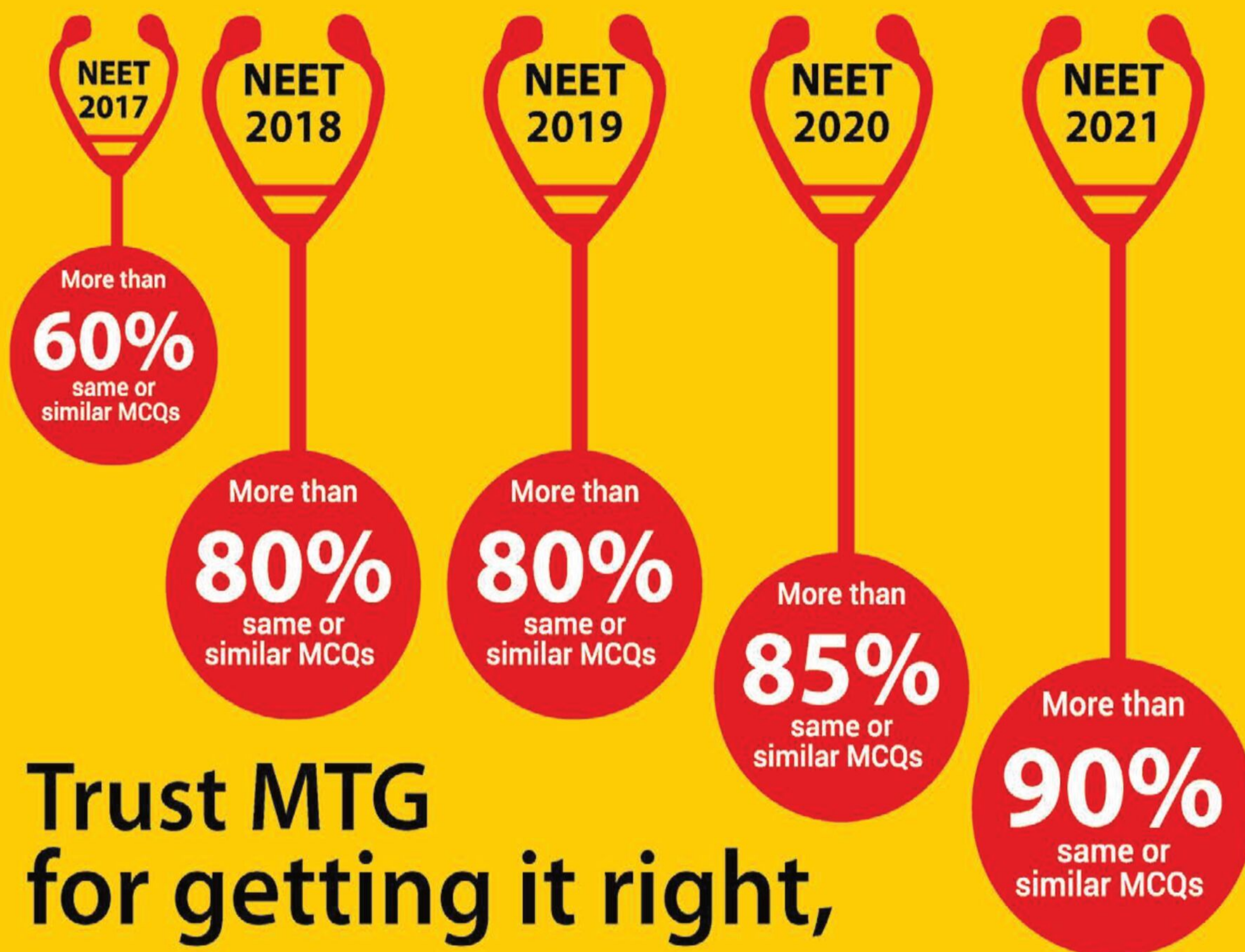
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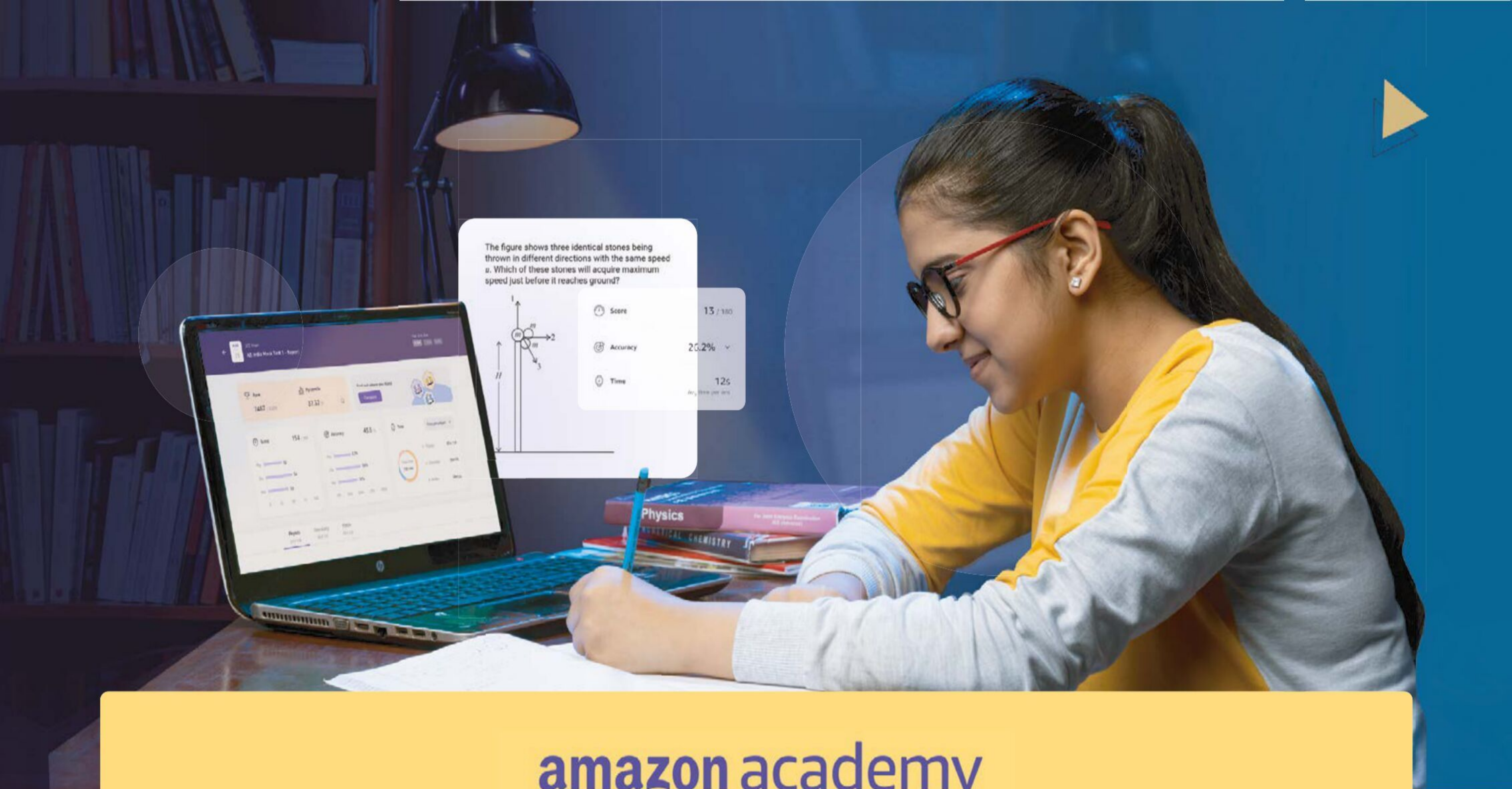


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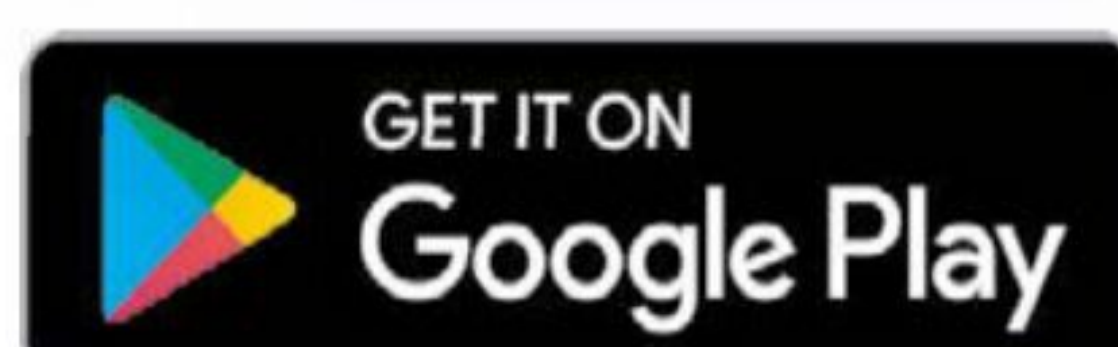


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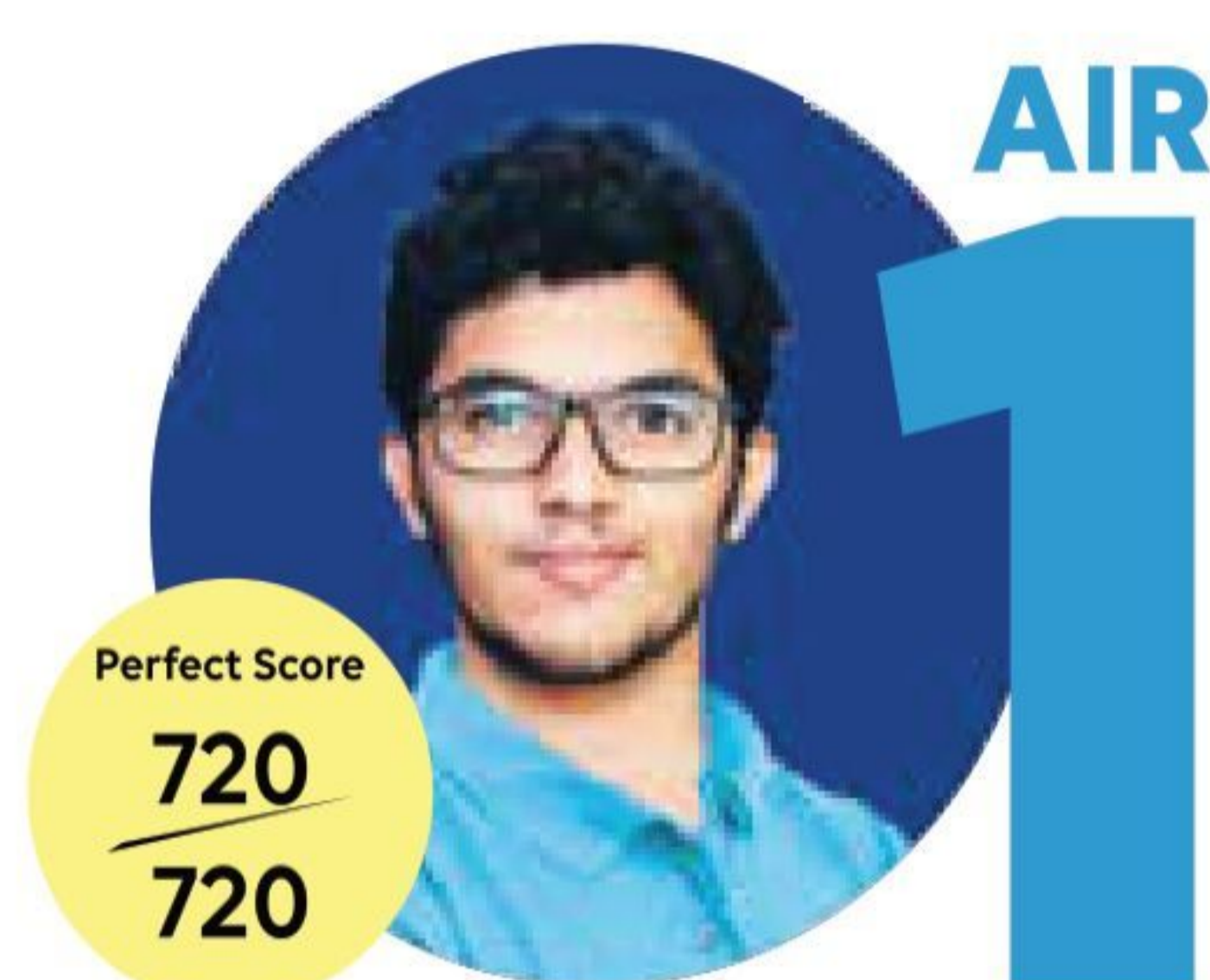


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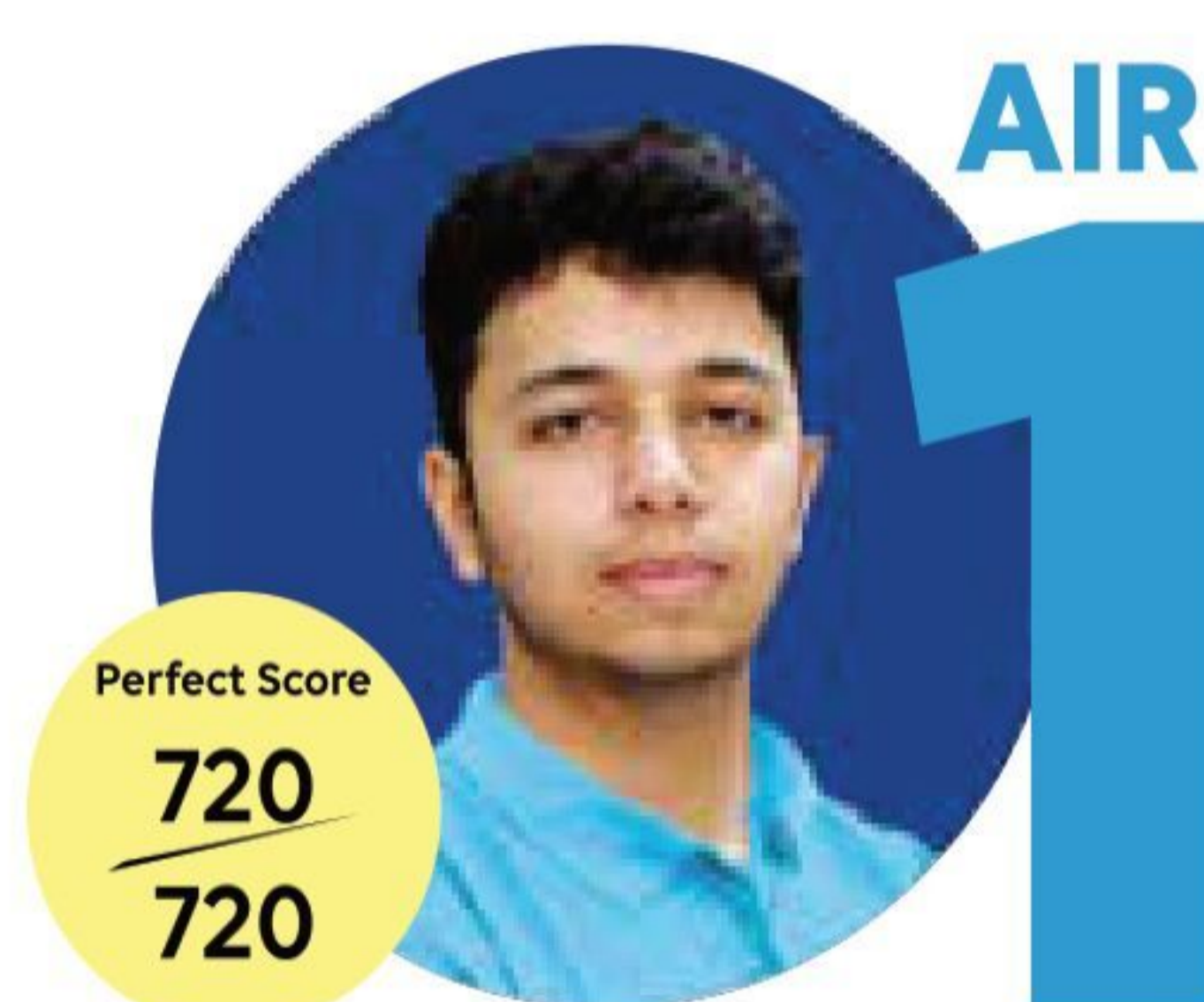
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